MECHANICAL ENGINEERING

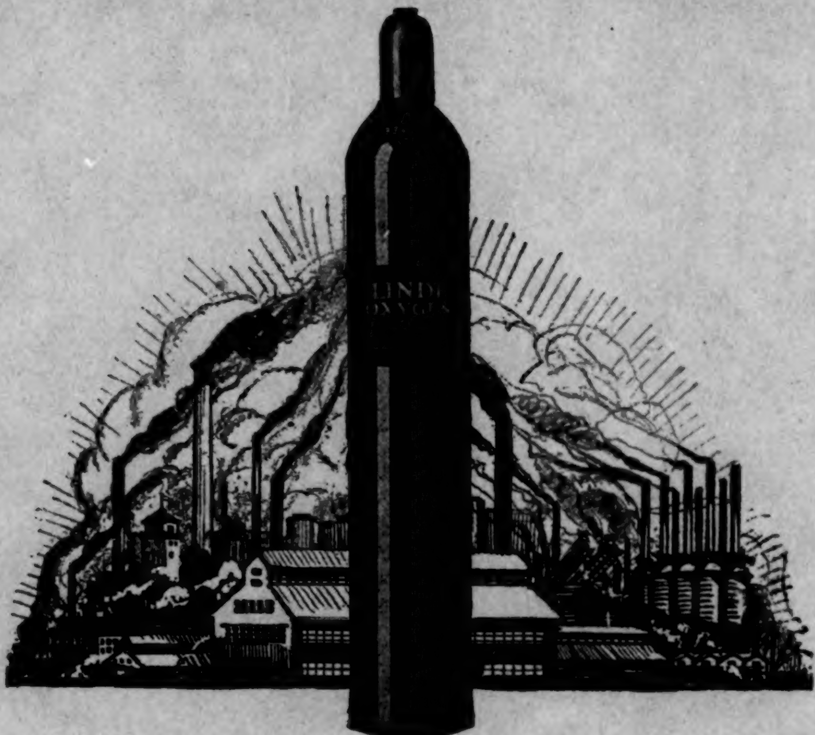
INCLUDING THE ENGINEERING INDEX

A.S.M.E. ANNUAL MEETING
NEW YORK, DECEMBER 4-7, 1922

Four days of splendid opportunities for professional fellowship at the Engineering Societies Building are to be followed by the National Exposition of Power and Mechanical Engineering at the Grand Central Palace on Thursday, December 7.

NOVEMBER ·1922

THE MONTHLY JOURNAL PUBLISHED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS



Mechanical Engineering

The Monthly Journal Published by

The American Society of Mechanical Engineers

Publication Office, 207 Church Street, Easton, Pa. Editorial and Advertising Departments at the Headquarters of the Society, 29 West Thirty-ninth Street, New York

Volume 44 November, 1922 **Number 11**

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Price 50 Cents a Copy, $4.00 a Year: to Members and Affiliates, 40 cents a Copy, $3.00 a Year. Postage to Canada, 50 Cents Additional; to Foreign Countries, $1.00 Additional. Changes of address should be sent to the Society Headquarters.

Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in section 1103, Act of Octocer 3, 1917, authorized on January 17, 1921.

Contributors and Contributions

Progress in Management

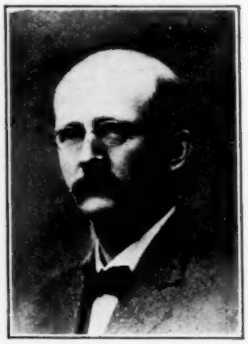
L. P. Alford

A feature common to a number of the local Management-Week programs was the presentation of a paper in which L. P. Alford, vice-president of the Ronald Press Company, New York, N. Y., and editor of *Management Engineering,* outlines progress in management during the past ten years. This paper is the leading article in the present issue of Mechanical Engineering.

Mr. Alford received his S.B. from Worcester Polytechnic Institute in 1896 and his M.E. in 1905. He gained his drafting-room and shop experience from the McKay Shoe Machinery Company and the United Shoe Machinery Company, both of Winchester, Mass., and was connected with the latter concern until 1907, when he entered the editorial field. He was engineering editor for four years and editor-in-chief for six years of the *American Machinist,* resigning in 1917 to become editor of *Industrial Management.* His present position dates from 1920.

Economy in the Central Station

Designers of central stations will find inspiration in the article by George A. Orrok in this issue. After reviewing the development of power-station equipment, Mr. Orrok gives carefully compiled data as to the probable commercial economy of high pressures and high superheats. Mr. Orrok has intensively studied power plants both in this country and abroad, and for three years, 1911 to 1914, was consulting professor of steam engineering at Brooklyn Polytechnic Institute. His book, Engineering of Power Plants, written in collaboration with Prof. R. H. Fernald, is regarded as an authority on power-plant design. Mr. Orrok, who for many years has been connected with the N. Y. Edison Co., also practices consulting engineering in New York City, and lectures at the Graduate School, S.S.S., Yale University.



Geo. A. Orrok

Spherical Gears

Charles H. Logue, whose paper on Spherical Gears shows the real connection between bevel and spur gears, points out the necessity for a difference in the design of the teeth heretofore not considered. Mr. Logue was for sometime employed by the R. D. Nuttall Company, of Pittsburgh, as draftsman, engineer, chief engineer and mechanical superintendent, successively, after which he was for a year an associate editor of the *American Machinist.* From 1911 to 1913 he served the General Motors Corporation at Detroit as consulting engineer and since that time the Brown, Lipe, Chapin Co. of Syracuse, in a similar capacity.

Preservation of Decaying Wood Roofs

As an introduction to this subject, Wendell S. Brown, connected since his graduation from Brown University in 1911 with F. P. Sheldon & Son, industrial engineers of Providence, R. I., discusses the general theory of wood decay. He then describes methods employed in preserving wood roofs and enumerates essential factors in prolonging the useful life of repaired roofs. While in college Mr. Brown specialized in branches of civil, electrical and mechanical engineering closely allied with the design and equipment of manufacturing buildings and other industrial structures, and his work and study since has centered about this subject.

Standardization of Tools

Suggestions for the standardization of machine tools and of small tools are contained in two papers which were presented at the recent Springfield Regional Meeting of the A.S.M.E. The subject of machine-tool standardization is handled by Fred H. Colvin and Kenneth H. Condit, editors of the *American Machinist.* Mr. Colvin has been in editorial work since 1894, when he was the first editor of *Machinery.* Mr. Condit, a graduate of Stevens Institute of Technology and Columbia and Princeton Universities, taught civil engineering at the latter institution from 1913 to 1917. He has been with the *American Machinist* since 1919.

The second paper, on small tools, is by Carl J. Oxford, a native of Norway. Mr. Oxford came to this country in 1909, spent two years in the engineering department at the University of Michigan, and then served as tool draftsman with the Packard Motor Car Company, Dodge Brothers, and Nordyke and Marmon until 1916. The following year he was designing engineer for the Wilt Twist Drill Company. Since 1917 he has been in the service of the National Twist Drill & Tool Co. of Detroit, of which he is now chief engineer.

Rules for Pressure Vessels and Heating Boilers

In this issue appear proposed rules dealing with unfired-pressure vessels and proposed revision of the rules for heating boilers which are to be presented before a public hearing at the coming A.S.M.E. Annual Meeting in New York on December 4. These rules are the result of long periods of conscientious service on the part of the Boiler Code Committee and its various subcommittees. The pages pertaining to unfired-pressure vessels are of special interest as they relate particularly to the strength of welded joints, and the code submitted is an effort to insure safety without being unjustly prohibitive.

MECHANICAL ENGINEERING

Volume 44 November, 1922 No. 11

Ten Years' Progress in Management[1]

Management Stands as a Great Body of Knowledge and Practice to Facilitate the Operation of Industry —It is the Agency by which Community, State and Nation Shall Endure.

By L. P. ALFORD,[2] NEW YORK, N. Y.

TEN YEARS have passed since the Committee report on The Present State of the Art of Industrial Management was presented to The American Society of Mechanical Engineers. The request is now made for a review of the progress of management during the intervening decade. Unfortunately for the purpose of such a study, eight of these ten years were abnormal, many of the management changes and innovations introduced were of a temporary nature or were mere expedients, and it is difficult to separate them from other and more permanent developments.

The only satisfactory way to treat the review is to base it upon the report of 1912, which was well received and in large measure approved. This course has therefore been adopted.

At the outset we should recall and pay generous tribute to three of our late great leaders who aided in preparing that report and took part in its discussion: Frederick W. Taylor, the pioneer management; Henry L. Gantt, who humanized the movement; James M. Dodge, the earnest, constructive supporter. During our ten-year period these men of vision and power completed their life work.

To obtain information on the worth-while changes which have taken place, letters were written to management and industrial engineers, to executives of plants in various lines of industry, and to educators familiar with industrial developments. Many interviews were held with men having industrial and managerial responsibilities. The response to these requests has been most generous. The author is deeply indebted for the information received and expresses his sincere gratitude to all who have given aid.

The report of 1912 declared the new element in management to be: "The mental attitude that consciously applies the transference of skill to all the activities of industry." It also quoted[3] and endorsed three regulative principles:

a The systematic use of experience
b The economic control of effort
c The promotion of personal effectiveness.

New interpretations and expanded meanings have been given to these principles, but they have in nowise been weakened or susseded. One correspondent writes: "Note, for example, the nearly universal acceptance of the principles. . . ."

In answer to the question, "What steps have been made in the progress of management since 1912?" a wide range of opinion was expressed as shown by the following sixteen quotations from correspondents' letters. The first gives a particularly well-balanced judgment of the situation.

It seems to me that management has very definitely progressed in the last ten years along certain main lines.

In the first place, good management is more insistent today on knowledge as a basis of judgment, rather than the old judgment based on personal observation. Management is more and more demanding costs, a knowledge of inventories, monthly profit and loss statements, statistics, and records of all kinds as pictures of events on which to base judgment.

In the second place, management is now undergoing a definite metamorphosis in the matter of industrial relations, and managers are waking up to the fact, as a practical element in their business, that they owe more to their employees than mere wages, and that whistle blow and hustle are not all there is to factory operation.

It is this belief and the spirit developing, rather than the volume of the action up to date, which is a matter of very definite progress in the past ten years of management.

Ten opinions, three to the effect that management has retrogressed or made little or limited progress, and seven stating the belief that progress has been made and mentioning certain details of improvement, are grouped to present a contrasting though in the main favorable picture.

Management (the directing group) has retrogressed in its acceptance of the principles of management, while labor has materially progressed toward a broader acceptance of these principles.

I believe that very little progress has been made in the adoption of scientific-management principles in industries outside of metal working with a few notable exceptions.

The main advance, and that lamentably slow, has been in putting into practice knowledge already available previous to 1912.

During the past ten years, we have passed through the period of first glamour, then the reaction of a loss of confidence, and have finally evolved into the general recognition of the legitimate place of a new branch of engineering art and science—management engineering.

The important steps in progress in management during the past ten years have been from unintelligent rule-of-thumb management, through scientific management to intelligent management. The latter has advanced steadily during the decade.

The greatest progressive step has been toward standardization of appliances and methods.

The most definite progress made during the past ten years is the universal acceptance of the merits of specialized production and standardization of design. These two steps have opened the way to a third simplification of method.

The reaction from destruction and waste incident to warfare and reconstruction has been toward the elimination of waste in industry as a management function. Waste in all forms has been more closely observed than hitherto, especially during the past two years. The effort to do away with waste has led to the fixing of budgets and the determination of cost standards.

Important steps in the progress of management since 1912 are:

a Greater use of facts in the establishment of the standards by which business is conducted.

b Broader recognition of the principle that industry exists for service to humanity.

c Greater appreciation of the importance of regularization or control in the successful conduct of the industries.

d Wider understanding of the economic value and importance of the management engineer in the operation of business.

There has been a great increase in the use of specifications not only to govern purchased materials but also to attain uniformity of process, quality and cost, and thus to insure reliability of product. Many plants now have well-equipped laboratories staffed by scientific men and some regularly employ consulting scientists. In the larger corporations research laboratories are not uncommon. Few of these departments are over ten years old and they evidence a rapidly growing appreciation of pure science as a tool of management.

The need of early and reliable figures as a mechanism of management has caused many companies to prepare monthly a complete statement of their business and earnings. A constantly increasing number of companies are publishing annually a detailed statement of their financial condition and many are publishing such statements quarterly. This voluntary publicity indicates a sincerity and frankness rare in management of an earlier decade.

[1] Brief reviews of recent developments in the United Kingdom and Germany which were also presented during Management Week, immediately follow the present paper.

[2] Editor *Management Engineering*. Mem. Am. Soc. M.E.

[3] *American Machinist*, vol. 36, p. 857, The Principles of Management, by Church and Alford.

Presented during Management Week, Oct. 16–21, 1922. To be read by title at the Annual Meeting, New York, December 4 to 7, 1922, of The American Society of Mechanical Engineers. Abridged by the omission of 11 appendices. Copies of the complete paper may be obtained gratis on application. All papers are subject to revision.

The final quotations in regard to progress, five in number, discriminate between management form and substance. Progress is indicated in both of these aspects.

The biggest and most lasting accomplishment in the inculcation of management principles is that, like religious teaching whose significance has been forgotten during years of prosperity, they again in the years of depression following the war developed a new significance in the minds of the thoughtful. A principle is not established in the actual social inheritance of the race—as a step forward—until man has applied it to himself and seen whether its application makes him a better man in his social relations. So management principles are being used as yardsticks to measure individual industrial development. This means that these principles are becoming a subconscious part of the mental equipment of industry, and not only is this real progress, it is fundamental.

The development and use of the Gantt chart is the most important step of progress, because it calls attention to the movement of facts, to the necessity of basing decisions on facts rather than on opinions, and because it helps managers to foresee future happenings.

A second important step is the change in the method of installation from the old type which organized from the top down to the new type which builds from the bottom up.

A third important step is the development of the theory that the cost of an article includes only those expenses actually incurred in the production of the article, and that the expenses of maintaining one machine in idleness cannot be charged into the cost of the output of another machine. Along with this theory came the development of a method of arriving at costs of idleness and work.

Probably the greatest progress consists in a better understanding of the problems of management with a particular acceptance of the facts to which Taylor called attention, that management is an art which may be practiced advantageously through the application of certain principles and the scientific method. I do not think, as yet, that the great majority of men at the head of industries have anything like an adequate understanding of scientific management, nor that they are able to distinguish between form amd substance in this respect. They have, however, apparently emerged from the attitude of opposition and mistrust of so-called scientific management, but are satisfied with a superficial application of the principles of management.

The important steps of progress made in management since 1912, I would say, are as follows. The order in which they are named is not significant:

a A greater appreciation of the human factor in industry.

b The growing recognition that employees should have a voice in the management as relating to those questions that directly affect them.

c The recognition of the strategic position of shop foremen and the necessity of more carefully selecting and training them.

d The increased recognition of the value of fundamental principles.

e The recognition of, and in a large degree the adoption of, standard systems of cost accounting from the point of view of timeliness, as a barometer rather than history, as an instrument of production rather than a matter of finance.

f A great development in mechanical equipment, combined with improved plant layout and building plants to fit manufacturing process.

g A marked advance in sales policies.

h A marked advance in substituting the trained, competent engineer for the old "cut-and-try" type of executive.

Using figures, which after all are most impressive, but basing those figures purely on my impressions, I would say that since 1912 industry has progressed in management by some 30 to 40 per cent in the appreciation of the fact that there is a management problem aside from the old concept, which was that the owner had simply to censor the things that happened within his jurisdiction. I should say that there had been a 20 to 25 per cent endeavor to install the mechanisms of management, considering in this figure the generally known stores systems, operation studies, wage-incentive plans, etc. In some cases, as for instance in stores control, the percentage might run a great deal higher, but I am refraining from increasing my estimate for it is my belief that these mechanisms that we have installed are, for the most part, of a makeshift character, and that in industry as a whole and considering only the larger companies, I doubt if more than five or six per cent are possessed of mechanisms at all acceptable in the final scheme of what management should do and possess.

As to the real concept existing today of what management is, and what conditions must be considered, influenced and coördinated to bring about the situation which should exist I doubt if more than one-fifth or one-fourth of one per cent of the companies in this country possess a knowledge or even appreciation of what is real management.

Combining and weighing these carefully prepared statements and adding to them certain well-recognized facts, there emerges a group of factors of varying importance which mark the progress of management during the past decade. These naturally arrange into three groups, of which the first concerns changes in mental attitude.

a The ancient controversy as to whether management is a science or an art has subsided, with increased recognition of the scientific basis of management.

b The attitude of opposition and mistrust toward management and the passionate antagonism to the installation of management methods have in general disappeared.

c Among those responsible for the carrying on of industry there has grown an appreciation of the existence of problems of management. (The appointment of Herbert Hoover as Secretary of Commerce and General Dawes as Director of the Budget reflect an appreciation by the Government of the need for management in our national affairs.)

d Acceptance of the principles of management has broadened among engineers, executives in industry, and educators.

The second group of factors of progress concerns the application of management methods.

e The engineering or scientific method has extended in industrial cost accounting. Among the developments are uniform cost-accounting systems (Appendix No. 1 to the complete paper lists 64 manufacturers' associations which have adopted such systems), the theory and method of determining and applying standard costs, the methods of determining idleness losses, the forecasting of sales leading to long-term production schedules, and the budgeting of future expenditures.

f Appreciation of the possibilities and advantages of standardization, simplification, and elimination of waste has spread rapidly during the past two years.

g The demand for knowledge, facts, as a basis for judgment has grown insistent in all good management. This has led, among other developments, to a widespread use of specifications and graphics as a means of recording and communicating management knowledge. (The first modern book on graphics in the English language was published as recently as 1910. The Gantt-type control chart has been developed into its present form since 1917.)

h Management methods have been applied or installed in practically every manufacturing industry, in distributing concerns and in institutions. (The report of 1912 listed 52 industries in which some form of management had been installed. A similar list prepared in 1922 would group all the branches of American industry.)

The third and final group of these factors concerns especially significant developments, which after being stated are subject to explanation and comment.)

i Management activities have broadened far beyond the installation of those mechanisms which are usually associated with the Taylor System, and which were emphasized in the report of 1912. (Appendix No. 2 to the complete paper lists 77 items of management work arranged under four headings: General, Labor, Material, Equipment.)

j Some eight or ten of the leading American engineering schools have established courses in management since 1912.

k Appreciation of the importance of the human factor in industry and attempts at its study from a fact basis have been the most striking management development.

l Management engineers have declared that the service motive must prevail in industry and that all questions concerning human relationships must be considered in a spirit devoid of arbitrariness or autocratic feeling.

Management Mechanisms

To secure information as to the use of management mechanisms the question was asked, "What (if any) mechanisms of management do you consider as generally accepted (*a*) in principle, (*b*) in practice?" From correspondents' replies the following twelve quotations have been selected.

I do not believe that any of the mechanisms of management are generally accepted in principle or in practice.

I know also that even where some of these things (mechanisms of management) have been established and we hear about them and might conclude that the firm using one or more of them is quite advanced, it often is not at all so. The feature described is only an unrelated "stunt," not supported

by a complete coördinated system of administration and usually begins to go to pieces not long after it is installed.

There is at the present time a retrograde movement in regard to the building up of stores and making operation studies. However, as I see it, this is merely a temporary depression in the curve, and I believe that the general tendency of this curve is upward with a very slow ascending grade.

Incentive wage-payment plans have had a temporary setback due to labor conditions caused by the war and to the reluctance of managers in general to consider such plans in any other light but of profit to the company. I do not think that the main service which the incentive plan can give—namely, that of stabilizing relations between employers and employees—has been given sufficient attention by the management.

I believe that such mechanisms as balance of stores, routing, operation, studies, incentive wage plans, personnel work, etc , are generally accepted in principle, but that efforts to install them frequently (perhaps most of the time) miscarry, and either accomplish little or no good. This is often due to a failure to see to it that details connected with the mechanisms are fully understood and looked after.

In a general way, the mechanisms of management are widely accepted now in principle and much less widely in practice.

Undoubtedly, good storeskeeping is becoming very generally accepted. We know that unless we keep accurate records of the materials used we cannot get the most satisfactory results. I think storeskeeping is accepted both in principle and practice as well as the intelligent study of operations.

I believe that balance of stores is accepted in principle and in practice, that is, in so far as a written record of quantities in stores is kept in the office rather than in a storeroom, and that a minimum or order point is predetermined and an order placed when it is reached. It is generally accepted in principle, though not in fact, that an incentive wage-payment plan is desirable and effective. It is accepted in principle that facts are shown on charts better than in tables of figures.

In principle, undoubtedly, all of the main mechanisms of management have been thoroughly established.

In a great measure all of the mechanisms of management as developed by Taylor and his immediate associates have been generally accepted in principle. But while they are being widely applied, my impression is that in great majority of the cases the application is half-baked in character and the results, while they may be satisfactory to the companies concerned, are far from being so satisfactory as they should be, either to the management or to the employees. My experience indicates that in most such cases an application such as Taylor would have approved will almost invariably result in increased production ranging from 30 to 100 per cent or more, depending on the nature of the business.

The following management mechanisms have been accepted in varying degrees:

Stores Control. In principle and practice very generally.

Operation Standardization. (*a*) In technical aspects, generally in principle, fairly so in practice. (*b*) In personal aspects, fairly accepted in principle, to a limited extent in practice. [By (*a*) I mean speeds, feeds, equipment, tools, etc.; by (*b*) motion and time studies of human elements.]

Wage-Payment Incentives. Generally in principle and in practice so far as direct labor is concerned. But little application has been made to indirect labor.

Cost Accounting. Generally accepted both in principle and practice.

Selection and Training of Employees. Fairly well accepted as to principle, but little in practice.

Purchasing Control. Generally as to both principle and practice.

Scheduling and Planning. Fairly well accepted in principle. Limited in practice in some industries, well established in others.

I find mechanisms being accepted one by one without a full realization of the part they are to play in the scheme as a whole. That is to say, I will find a company suddenly appreciative of the value of operation studies. It will thereupon proceed to organize to make operation studies, and for the time being in its new enthusiasm it pursues what threatens to become a hobby rather than a part of its business. This pursuit at times leads into the installation of other mechanisms. It begins to recognize, from the operation studies, that a balance of stores is essential, and that a wage incentive is desirable. I find, however, that this progress is accidental rather than planned.

Mechanisms of management such as are discussed in the 1912 Report are generally accepted in principle, but poorly carried out in practice in the majority of establishments. On the other hand, few, representing the best organizations, have developed these things to a degree which serve as valuable guides.

Planning and control are used more and more extensively in plan operation. The tendency of the majority, however, is to try to gain the benefits of more intensive control through partial makeshifts which record past accomplishments instead of actually planning the work. The importance of control, in fact, in increasing production through elimination of idle time, men, and machinery, is not yet recognized except in a few markedly successful establishments. The developments along these lines are being undertaken frequently through inexperienced, low-grade men, who adopt mechanisms as such, instead of developing existing methods on fundamental principles.

Balance of stores is accepted almost universally in principle and widely used in practice. Accountants have been quick to recognize its advantages, and have made it an essential part of their accounting mechanism. On the other hand, two of the most vital features for assisting in the control of production, the column of "stores apportioned" and the entering of "minimum" quantities of each item permissible, are apt to be omitted.

The development of time study and job analysis, while widespread, has been unsatisfactory; piece rates are more and more universal, but their determination is still largely on a basis of past performance, aided by time studies which simply record these performances in more detail instead of analyzing the operations and determining the methods and units which will give most satisfactory results. There is still lack of appreciation of the fact that the chief aims of time study and job analysis must be:

a To resolve the operations into such units that they can be recombined to provide for all variables;

b To take advantage of this unit study to eliminate unnecessary operations, substitute improved methods, and remove defects in equipment and in control.

c To enable the workman to earn more money often with less effort; and,

d To indicate means for improvement in quality and practicable methods for making the improved quality routine.

To these statements of the acceptance of management mechanisms it is possible to add a few quantitative facts. It will be recalled that the field reports of six industries, given in the Report of the Committee on the Elimination of Waste in Industry of the Federated American Engineering Societies, were based on an extensive questionnaire. The replies in four of these industries—metal trades, boot and shoe manufacturing, men's ready-to-wear clothing manufacturing, and printing—have been studied to show the use of mechanisms of management. The facts brought forth are presented in six tables included in the complete paper, of which the accompanying Table 1 is a summary. The questions from whose replies the facts were drawn are given in Appendix No. 3 to the complete paper.

TABLE 1 SUMMARY FOR 51 PLANTS IN 4 INDUSTRIES

Mechanisms of Management	Boot & Shoe, 8 plants			Men's R. M. Clothing, 9 plants			Printing, 6 plants			Metal Trades, 28 plants			Totals, 51 plants		
	None	Inadequate	Good	None	Inadequate	Good	None	Inadequate	Good	None	Inadequate	Good	None	Inadequate	Good
1 Selection and Placement	0	6	2	0	4	5	0	5	1	[1]0_0	6_4	10_8	0	25	26
2 Incentive Wage Plan	0	0	8	4	2	3	1	1	4	2_1	6_3	8_8	8	12	31
3 Planning Centralized	4	0	4	4	2	3	3	2	1	3_1	8_2	5_9	15	14	22
(*a*) Routing, order of work	4	1	3	4	2	3	5	0	1	5_2	6_2	5_8	20	11	20
(*b*) Scheduling, machine assignments	3	3	2	3	2	4	3	2	1	4_1	5_3	7_8	14	15	22
4 Time Study	5	2	1	3	3	3	5	0	1	6_2	2_1	8_9	21	8	22
5 Cost Control	1	3	4	2	5	2	3	2	1	4_2	3_6	9_4 1	12	19	20
6 Idle-Time Analysis:															
(*a*) Men	7	1	0	6	3	0	5	0	1	13_8	0_0	3_4	30	4	8
(*b*) Machines	7	1	0	8	1	0	3	0	3	9_6	1_0	6_6	33	3	15
7 Purchase Control	1	4	3	3	1	5	3	2	1	3_1	4_1	9_{10}	11	12	28
8 Balance of Stores	1	1	6	3	1	5	4	1	1	2_1	4_1	10_{10}	11	8	32

[1] The two figures shown separately in the metal-trades columns represent totals for the 16 plants (upper figure) covered by the regular questionnaire, and the plants (lower figure) which filled out only a condensed questionnaire.

Turning to Table 1 and arranging the eight mechanisms in the order of the number of plants in which they are installed *in some form*, we have:

1 Selection and Placement	5 Cost Control
2 Incentive Wage Plan	6 Planning (routing, scheduling)
3 Balance of Stores	7 Time Study
4 Purchase Control	8 Idle-Time Analysis.

Rearranging in the order of the number of plants where the installation is *good*, we have:

1 Balance of Stores	5 Planning (routing, scheduling)
2 Incentive Wage Plan	6 Time Study
3 Purchase Control	7 Cost Control
4 Selection and Placement	8 Idle-Time Analysis.

The weight of opinion and fact brings the conclusion that certain mechanisms of management have made decided headway in acceptance both in principle and practice, and form an assay of four industries the importance of application yields two groups:

a Balance of Stores	*b* Cost Control
Incentive Wage Plan	Idle-Time Analysis
Purchase Control	Planning
Selection and Placement	Time Study.

In the installation of such mechanisms a significant change is becoming evident. In early days of management the mechan-

isms concerned the physical means of production. They were originated by the executives and were ordered into the shop.

At a later date, as emphasized in the report of 1912, the value of methods which concerned the worker was appreciated. Training was the first to have any widespread trial. But the attitude was still the developing or forcing of a mechanism from the top downward.

Within the decade under review, another attitude has been adopted in a few instances. It seeks to make the foremen and even the workers consciously parties to the development of the plan before they are put into effect. It endeavors to arouse interest, to inspire to achievement, to release creative energy. Its effect is to install methods and mechanisms from the bottom upward with celerity and improvement in personnel relations.

Management Education of Engineering Grade

Where there was probably but a single college course in management in 1912, there are now eight, in these institutions:

Columbia University
Massachusetts Institute of Technology
New York University
Pennsylvania State College
Purdue University
University of Kansas
University of Pittsburgh
Yale University—Sheffield Scientific School.

The subjects in these courses are given in a fourth appendix to the complete paper. In addition to this form of instruction, management subjects have been introduced in mechanical-engineering courses. Examples are the pioneer work at Cornell University—Sibley College, and at the Worcester Polytechnic Institute.

The growing importance of this branch of engineering education is shown by the number of men enrolled. An appendix to the complete paper (No. 5) gives the enrollment of all students in colleges of engineering in the United States for the school year 1921–1922. The total is 53,414. The number in management courses is 1123, identified as—

Administration Engineering	725
Industrial Engineering	389
Industrial Management	9
Total	1123

The 277 students in "Commercial Engineering" courses have not been included, although they undoubtedly received some instruction in management subjects.

While these management courses in the beginning were based on mechanical engineering their character seems to be changing, so that it can now be said that they are based on engineering broadly, with emphasis on fundamental subjects. There is a tendency to lessen or limit qualitative instruction in details of production. Without doubt, the character of the instruction is improving as teachers gain a wider and sounder experience in the application of management principles.

The significance of this new branch of engineering education is not its extent as measured in numbers of students, but in the fact that at least eight leading institutions have added it to their regular and older courses.

It is unfortunate that no common name has been adopted for these courses; at least four are in use.

The Human Factor in Industry

The report of 1912 presented the human factor in industry with particular emphasis on the responsibility of managers and executive to train their workers and the same thought was prominent in the discussion. According to the comment of the Committee in its closure, one of the striking characteristics which had already gripped attention was "the presence throughout the discussion of a human spirit in keeping with the best trend of thought toward social justice," and "the development that has taken place within the last few years leading to a new appreciation of the needs and rights of employees."

Henry P. Kendall in his discussion of the report[1] outlined the operation of an employment department which he had initiated. The employment man interviewed applicants, selected workers by tests, placed them in positions for which they were fitted, required medical examinations, kept records of each employee, kept in touch with the foremen in regard to the deportment, skill and earning power of the employees, had charge of discipline and discharge, and gave advice, suggestions, and sympathy to the workers throughout the organization.

These disclosures in outline foreshadowed a great wave of industrial relations work which swept through American industry after the outbreak of war. The movement received its impetus from the demand for workers in a time of extreme shortage, and was influenced by emotionalism and social theory. With the return of a labor surplus in 1921 the unsound features have in the main disappeared, leaving but vestiges of the methods and devices which were initiated in such profusion.

The present situation as regards personnel work is appreciation that personnel problems exist, recognition that their solution is a responsibility of management, and a growing realization that job analysis, selection, placement, and training can be put on a scientific basis.

Associated in thought, though not necessarily a part of any employment or industrial relations plan, is the rise of works councils in American industry. Several hundred have been established during the past decade. In August, 1919, there were 225, in February, 1922, approximately, 725.[1] Their development has been in response to a desire on the part of the workers for a means of expressing their beliefs and wishes in regard to matters arising in employment, and on the part of the management for a means of communicating with their employees and gaining and holding their confidence and good will. The movement but emphasizes the fact that the development of the relationships of employer and employed is a responsibility of management.

The Service Motive

Management engineers as a group have declared that the service motive must prevail in industry, that everything planned and done must be directed to securing the worthy result of producing useful goods with a minimum expenditure of time, material, and human effort. One of the clearest statements was written by Henry L. Gantt a few weeks before his death.[2]

> We have proved in many places that the doctrine of service which has been preached in the churches as religion is not only good economics and eminently practical, but because of the increased production of goods obtained by it, promises to lead us safely through the maze of confusion into which we seem to be headed, and to give us that industrial democracy which alone can afford a basis for industrial peace.

This disinterested purpose has been accepted as an ideal for the entire engineering profession, by becoming the challenging thought in the preamble to the constitution of the Federated American Engineering Societies.

To the factors dealing with the steps in the progress of management which have been discussed, should be added a consideration of the extension and growth of management societies which has taken place during the past ten years.

The earliest was the Society for the Promotion of Scientific Management, founded informally in 1910 and organized in 1912. In 1916 the name was changed to the Taylor Society, and in 1918 it was reorganized. Appendix No. 6 to the complete paper gives details of the growth of this society.

The first national organization to deal with personnel matters beginning with the training of workers was the National Association o Corporation Schools, founded in 1913. By 1917 its work had broadened to include all of the activities classified as human relations. In 1920 the name was changed to the National Association of Corporation Training. In May, 1922, it was merged into the National Personnel Association. See Appendices Nos. 7 and 11 to the complete paper outlining the different steps in the development of this society.

In May, 1917, in response to a war demand, The Society of Industrial Engineers was founded. In 1919, it was functionalized and has carried on the activities of a professional engineering so-

[1] Trans. Am.Soc.M.E., vol. 34, p. 1208.

[1] See Reports of the National Industrial Conference Board.
[2] Organizing for Work, p. 104.

ciety. See Appendix No. 8 to the complete paper. This Appendix describes the formation of the society.

A second personnel society was organized during the war, May, 1918, under the name of the National Association of Employment Managers. On March 1, 1920, the name was changed to The Industrial Relations Association of America. May of that year registered the peak of the movement, the Chicago National Convention being attended by 5000 persons. The change in business conditions affected it adversely and in December, 1921, the Board of Directors voted to disband the organization. Early in 1922 it was merged into the National Personnel Association. See Appendices Nos. 9 and 11 to the complete paper for details of the growth of this association.

Although The American Society of Mechanical Engineers provided the forum for the presentation of the earliest papers on management, no part of that society was particularly devoted to management matters until the formation of Professional Divisions in 1920. In July of that year, the Management Division was organized. It soon led all of the other Professional Divisions in membership and has held that position ever since. Appendix No. 10 to the complete paper defines management and sets forth the purposes of this division.

There are, therefore, four societies concerned with management—three in its engineering to technical aspects, and one restricted to personnel matters. The combined membership, not discarding duplications known to exist, is 4041.

Management Division A.S.M.E.	1,740
Society of Industrial Engineers	1,032
The Taylor Society	769
National Personnel Association[1]	500
Total	4,041

This membership is growing rapidly; more than one-half has been gained during the past two years for that period spans the founding and growth of the management division of The American Society of Mechanical Engineers.

Within the last two years joint activities have been originated among these and other societies with the promise of benefits to all who are concerned with management. Included are: Development of a management terminology; development of a classification for management literature; standardization of management graphics; and development of methods for the measurement of management.

Management Results

The report of 1912 stated that the results of good management had been: "A reduced cost of product, greater promptness in delivery with the ability to set and meet dates of shipment; a greater output per worker per day with increased wages; and an improvement in the contentment of the workers." There was no evidence at that time that goods had been reduced in price to the consumer.

To a degree this evidence has now been supplied. There are examples where good management has held down prices during a period of inflation and reduced prices as soon as business conditions changed. These acts benefited the consumer. Therefore the management movement can be said to have earned its economic justification.

Management as developed through a generation of effort stands today as a great body of knowledge and practice, to facilitate the operation of industry and the conduct of business. Through organization it determines policies, plans basically over long periods of time and fixes impersonal relationships; through preparation it plans in detail how, when, and by whom work is to be done; through direction it initiates and maintains the processes of production and distribution.

Here, then, is a tremendous, hitherto unknown engineering tool. What is it for? The answer is a spur to every engineer and industrial executive:

Industry and business as developed in modern civilization must continue else infinite misery will overtake the human race. Management is the agency by which community, state, and nation shall endure.

[1] The National Personnel Association also has 129 company members.

DEVELOPMENT OF MANAGEMENT IN THE UNITED KINGDOM

By James F. Whiteford,[1] London, England

In general, it may be stated that management practices in the United Kingdom are following very closely the same sequence of developments that has been instituted in American industries. The application is a few years late, but the best portion of the practices in American industries are being fairly generally accepted.

Standardization. The most important development in this country during the past ten years has been a general acceptance of the principle of standardization. One instance will serve as an illustration. Ten years ago one prominent automobile manufacturer supplied his customers with 26 different designs of cars. Today his main advertisement consists of, "This is the only design we make." A manufacturer of food products who had over 3000 lines in his price list ten years ago, now manages to supply the needs of his customers with 215, which includes several packings of the same article.

Specialization. Concentration has become very evident in respect of personnel as well as in the nature of the product, and more and more the individuals of each organization devote their whole attention to certain definite functions the scope of which is more and more limited. Employment of personnel, planning of work, centralized control through statistics, and greater attention to welfare of the employees are the noticeable features in present-day industrial works in this country. This is merely repeating the experience again in American industries.

Employee Representation. Very great advances have been made in British industries in providing opportunity for the employees to participate in the management of the industries. This is particularly true in respect of matters pertaining to working conditions, discipline, and methods of wage payment. In some factories the Whitley Council idea has been adopted in part, the council representing the actual participation of fully 10 per cent of the total employees engaged, but the form of participation varies in each factory.

In general, the Whitley Council as originally promulgated has not been accepted. The ultimate objective was the complete control of each industry by employers and employed, the whole country to be organized under the control of one council. The general and district councils were designed to provide joint management of the industry, deciding all questions of policy and other matters pertaining to the general welfare of the business, which plan was, in my opinion, unsound in principle, since it made no provision to include the buying public. The partial participation in the management has, however, been effected through this medium although one large labor union, the Amalgamated Society of Engineers, refused from the start to sanction the idea or support the movement in any form. The general results obtained are, however, sufficient to warrant the statement that employees' representation is in general use for dealing with matters pertaining to discipline and conditions of employment. It is doubtful if there will be any great extension of duties.

Costs and Statistics. Extensive development has become evident in British industries in respect of improvements in methods of costing, and in providing works statistics for the guidance of the management. In costing work the British manufacturers have not gone into the extensive detail which characterized the installation in American industries, but have contented themselves with providing for the main principles in this branch of factory accounting.

Buildings and Equipment. The new factory buildings are ample evidence of the fact that provision of suitable working conditions and ample supply of light and effective ventilation are accepted as being very necessary in all factories, and provide a distinct contrast with the older buildings in this respect. Up-to-date machinery is also evidence, all of which indicates a new phase in the management of industries in this country.

Welfare. Canteens, playing fields, various forms of recreation, and other matters of similar purport are now receiving a great

[1] Industrial Engineer. Mem. Am.Soc.M.E.

deal of attention in all branches of British industries. These are now regarded as very necessary supplements to the ordinary factory buildings and equipment. In many factories rest periods are in use, and in certain of these provision is also made for providing liquid refreshments during those periods. On the whole, there is every evidence that the industrial executives have realized the necessity for providing for the general improvement in the welfare, in working conditions, of their employees.

Wage Payment. Many forms of wage systems are in use, but straight piece work still predominates. Government regulations provide that all employees on differential wage systems shall be provided with data enabling them readily to calculate their earnings. This is probably one of the main reasons why piece work continues to be used extensively. The trades unions in the engineering, printing, and allied trades refuse to accept any form of differential wage plan.

Time Study. The employment of the stop watch in the development of wage-payment standards is being adopted gradually. Its use is still considerably behind American practice, but it is now being generally recognized that basic data are necessary for planning work as well as for wage-payment purposes.

THE DEVELOPMENT OF SCIENTIFIC INDUSTRIAL ORGANIZATION IN GERMANY[1]

By G. SCHLESINGER,[2] CHARLOTTENBURG, GERMANY

SCIENTIFIC organization in Germany has developed only within the last twenty years. Before that time practical and far-sighted men had sought to adapt the old workshop organization to the rapidly growing industrial works; the engineer devoting his attention to plant and equipment; and the manager occupying himself with questions of bookkeeping and shop accounting. But it was all done without coördination and without system.

Then it came about that the heads of the sales and technical departments of a leading firm of machine-tool builders (Ludwig Loewe & Co., Inc., Berlin) decided to coöperate, with the result that an organization was developed in this establishment that was far superior to that of any other industrial works. Later the head manager of the firm made what was for those times an extraordinary decision: he consented, in the interests of industrial progress in his country, to publish an account of the organization which had been built up in the course of six years. This publication made a deep impression on the industrial and scientific world.

Factory organizations can plan their layout and equipment, their working program, and their cost accounting. In this paper it is proposed to deal principally with cost accounting.

The plan of the accounting system employed by the Loewe Company is briefly as follows:

The factory costs as shown by the "general accounting department" were distributed over the different working departments through the medium of a "shop-record department." The combination of these two departments formed an account which in the general accounting department was called the "shop-record account" and in the shop-record department, the "central account." The distribution was very carefully conducted. A check-up would determine whether everything had been properly distributed. As regarded the shops, the quota would be determined by charging them pro rata to the wages of the workmen. The shops and branches had differentiated (proportionate) charges of the wages.

In a workshop manufacturing only standard parts, partly with very simple and cheap, partly with very complicated and expansive machines, separate costs (known as "place costs") were determined for the various working centers.

At the same time Sperlich published a work in which he recommended that the ordinary simple, flat addition for overhead be replaced by one to be determined separately for each production unit.

Soon after this, the Danish authority West and W. H. Bach of Germany adapted American improvements to German conditions, and later certain large industrial concerns engaged American experts to reorganize their plants in order to introduce American organization methods; but this did not go far beyond the experimental stage.

The only important publication at this time which deserves special mention and which is in a way a connecting link between the old empirical and the new scientific periods, is the work of H. Peiser, business manager of the Berlin-Anhalt Machine Works, Berlin-Dessau, published in 1919, in which a much closer connection is developed between the shop and general accounting department than obtained with Ludwig Loewe & Co.

Progress through Theoretical Investigation

When one takes into consideration the scientific trend of the German mind, it is not surprising that real progress has been made in this field through theoretical investigation. This progress is due to the work of Dr. Johann Fried. Schär, formerly professor at the Academy of Commerce of Berlin, and founder of modern commercial science.

Schär's idea of the future of factory accuntancy was made very clear to the initiated in his standard work, Bookkeeping and Balance, which has now reached its fifth edition.

In this work he deals, not with planning or management, but with capital, with which the very bases of factory organization are created. "Costs" are not calculated, but the factory capital or assets, the circulation of which is closely followed throughout the work. With a proper accounting system it should be possible to have the assets constantly under control through the monthly intermediate balance *without* inventory.

Schmalenbach, a pupil of Schär's, corrected a fault in the latter's system which made itself particularly apparent in the postwar period. It is this same fault which Gantt scores in his book Organizing for Work, and which he claims exists in some of the most progressive American industrial plants. Schmalenbach in his theory of "*dynamic balance*" recommends the separation of the cost accounting from Schär's capital accounting, which is objective and static. Gantt proposes to consider only those factors in a cost-accounting system which are directly concerned with production. Both are opposed to a distribution of the costs, with which the bookkeeping is burdened. Both wish to obtain the net costs of products constructively. The author does not know whether Gantt ever solved this problem. There is nothing to that effect in the above-mentioned book. At any rate he has read or heard nothing of the carrying out of the theories of Schär and Schmalenbach; but has found them applied in the practical work of Ernst Just and Elizabeth Vöhl, with whom he coöperated during four years and whose work will now be described in detail.

The Work of Just and Vohl

The progress of these two is based on philosophical principles and practical experiments, which latter were conducted in about 600 small industrial plants in twelve different branches of industry. The result was the Hansa accounting system with its four successive stages. With this completed they consulted Schär, who gave them the benefit of his wide knowledge of accounting and organization problems. His theoretical conclusions agreed with the practical results they had obtained and helped greatly in the explanation of these complicated problems.

Then followed twelve years of practical work in large and medium size factories representing all branches of industry. The author has been specially privileged in being made acquainted with the results of this work and he is convinced that industrial plants could be operated with far greater success if they would adopt this system of organization.

Just starts with a search for objective measures which will serve as a substitute for the "experience and intuition" characterizing present-day methods. The aim of this scientific research is to find the vital law of a manufacturing plant through analysis of its problems and to build it up anew.

In Just's practical mind the scientific requirements of Schär took shape in the following problem: How can what goes on in a factory —the expenditure of capital and the creation of new capital— be actually and ideally presented simultaneously? The problem is therefore this: that every movement of the industrial capital

[1] Abridged.

[2] Professor of Engineering, Technische Hochschule. Mem. Am.Soc.M.E.

in its circulation from stationary capital (assets) to journal assets (production costs, overhead) to production assets (products) and back again to stationary capital (stock assets, customers' orders, bank deposits) be once actually and once ideally presented.

Just and Vöhl found the solution of this problem through combining the ideas of Ludwig Loewe, Schär and Schmalenbach, and arranging them into three separate accounts:

1 One for stationary capital = calculation of assets account
2 One for journal assets = shop account
3 One for production assets = products account.

These three accounts are kept according to the principles of double-entry bookkeeping, and are therefore self-controlling.

However, these three accounts are kept separately only during the period of business activity. On closing day—intermediate balance, annual balance—they are combined and become part of the assets account. As they bear a fixed relation to one another and are combined on closing day, they therefore control one another.

Through the clear and systematic arrangement of the component parts of this accounting system, especially the production costs, only one accounting formula is required which, in contrast to former systems (Loewe, Peiser, American) does not charge everything to wages, which is distribution backward, but *builds up* from the bottom and makes its possible to recognize the influence of the separate factors, which was the aim of Gantt.

The author wishes now to discuss briefly the attitude of German industry to the scientific and practical development described.

The work of Just and Vöhl, which has not hitherto been made public and consequently cannot have been discussed, must necessarily be excepted. Unfortunately it must be admitted that leading engineering societies and industrial associations have not only disregarded the treatises of Schär and, to a certain extent, those of Schmalenbach, but have instituted a sort of counter movement with the argument that the work of Schär and his pupils does not meet with undivided approval. At the request of one representative engineering society, The Committee for Economic Production (AwF), a special committee was appointed consisting of twenty members, including engineers, merchants, industrial leaders, economists, scientific and practical experts, for the purpose of seeking out the best of the literature on hand, supplementing and improving it on the basis of their own experiences, drawing conclusions from the whole result, and publishing these as a "standard," somewhat on the order of the standard sheets on allowances, screw threads, pulleys, etc., published by the German Industrial Standards Committee.

This compilation was published in two editions in the years 1920 and 1921, under the title, Basic Scheme of Net Cost Finding, and was sent to all German industries.

It must be admitted that this "basic scheme" represents in no respect an improvement on those of Loewe, Peiser, or the American authorities. This result was to be expected when such difficult problems—probably the most difficult that technical and scientific industrial research have to deal with—are settled by majority conclusions.

German Industrial Attitude

While "practical" America is making every effort to build up a *scientific* system of industrial management, "scientific" Germany is thus returning to purely *practical* experience for guidance in the organization of industrial plants. But not all have taken part in this retrogression, and the author can at the same time report that the same head manager, Waldschmidt, of the Ludw. Loewe factory, who eighteen years ago permitted the epoch-making description of his work to be published, recently requested the practical research workers, Just and Vöhl, to discuss the basic principles of their work for the benefit of German industry at the Research Society for Scientific Management over which he presides. After two introductory addresses which were presented in April, 1922, Just and Vöhl, at the request of the above-mentioned society, prepared seven theses, in which they present their views of the factory-accounting methods now in vogue. Five distinguished professors of engineering and commercial science (Schär, Schmalenbach, Schilling, Schlesinger, and Wallichs) will take the opposite side in a debate to be held before the board of directors of the society on September 14 of this year, and it is hoped that this discussion will serve to bring about a radical change in works organization in Germany.

The theses are as follows:

Seven Theses for Discussion

I—It is *wrong* to place shop accounting in charge of the separate departments in such a way that a sales-accounting system is conducted under the sales manager, a shop-accounting system under the shop manager, etc. It is *right* to establish a uniform system of shop-accounting with a position within the administration corresponding to the following scheme:

a Management
b Work
  1 Outside work
  2 Inside work
c Auditing

The auditing should therefore be independent of the work, and both should supply the management with means with which to control the work.

II—It is *wrong* to attempt to bring about the necessary unity in accounting by forcing it into *one* accounting system (mingling assets, operating and sales accounts indiscriminately together). It is *right* to build up a unit system of accounting consisting of three divisions, which can be balanced separately during work. These divisions are:

1 Calculation of the stationary capital: *Calculation of assets.*
2 Calculation of capital used in factory operation: *Operating Capital.*
3 Calculation of capital gained from products: *Production assets.* On periodical closing days they must be combined.

III—It is *wrong* to build up an accounting system partly on a systematic and partly on an unsystematic basis as is usually the case. For instance:

1 Calculation of stationary capital systematically, according to principle of double-entry bookkeeping
2 Shop calculation unsystematically, as single-entry
3 Production calculation also as single-entry.

It is *right* to conduct the whole accounting system according to the principles of double-entry bookkeeping.

IV—It is *wrong* to determine the relation between (*a*) capital and production accounting and (*b*) capital and stock accounting in such a way that one must specifically explain the other. It is *right* to establish the inter relation of the three accounts similar to that between seller and purchaser as follows:

1 Determination of overhead: Seller or contractor is capital accounting, purchaser is shop accounting
2 Calculation of material and labor: Contractor is capital accounting, purchaser is production accounting
3 Calculation of shop costs: Contractor is shop accounting, purchaser is production accounting
4 Calculation of finished products: Contractor is production accounting, purchaser is capital accounting
5 Closing calculation (annual balance or monthly intermediate balance): Contractors are shop and production accounting, purchaser is capital accounting.

V—It is *wrong* to organize the accounting system in such a way that it computes (1) too late, (2) too seldom and (3) only with the aid of an inventory of (*a*) the assets and (*b*) the results. It is *right* to conduct the accounting in such a way that this information is obtained (1) during production of work, (2) once a month, and (3) automatically.

VI—It is *wrong* to determine the net cost value of products by means of calculation (by auditing). It is *right* to determine the net costs by means of accounts (so-called record-keeping) conducted on the principles of double-entry bookkeeping and which keep pace with production progress.

VII—It is *wrong* for different concerns in the same branch of industry to have separate systems of accounting, so that comparisons with regard to the elements of net costs cannot be made between them, and consequently agreements with workers, government authorities and trade competitors cannot be made on a known basis. It is *right* that every industrial association should require its members to adopt a uniform system of accounting to the end that intelligent comparison may be made.

The author, however, is witness to the fact that these theses present only conclusions from the practical work that these two have successfully carried out in the most widely different branches of industrial work. Besides their fundamental ideas, they have also developed working rules, methods and means for putting these ideas into practice.

In conclusion, the author would say that it gives him great pleasure to be able to acquaint the American industrial world with the results of scientific and practical industrial organization in Germany. He is convinced that after a long period of lagging behind, his countrymen have now caught up with Americans in scientific management. However, the deeper foundation that they possess and the greater economy of operating their system (they can carry out the work of accounting in factories according to their method with half the personnel that is required with the usual American system), will perhaps prompt American industry to take note of their organization, science and practice, as German industry once gladly and gratefully accepted advice and information from American sources.

The Commercial Economy of High Pressure and High Superheat in the Central Station

By GEO. A. ORROK,[1] NEW YORK, N. Y.

IN THIS AGE of progress when the designers of central stations of all types and kinds are vying with each other in the use of higher pressures and temperatures as well as multiplying the complication of the steam generator, prime mover, and auxiliaries, it is expedient to go back to the beginnings of the central station and by a review of the line of development get a broad perspective of the field of power generation which will enable us to apply, to the newer developments, those basic principles of commercial economy and efficiency necessary to a proper solution of the problem.

The earlier use of steam when its expansive force had not been discovered, is best shown by the Newcomen pumping installations, in which the steam was used at atmospheric pressure. Watt discovered the expansive force of steam and so improved the boiler, engine, and steam piping that 15 lb. gage could be used economically. From his time until about 1900 rising pressure kept pace with improvements in materials and in the design and construction of steam generators and piping, with occasional excursions into the realms

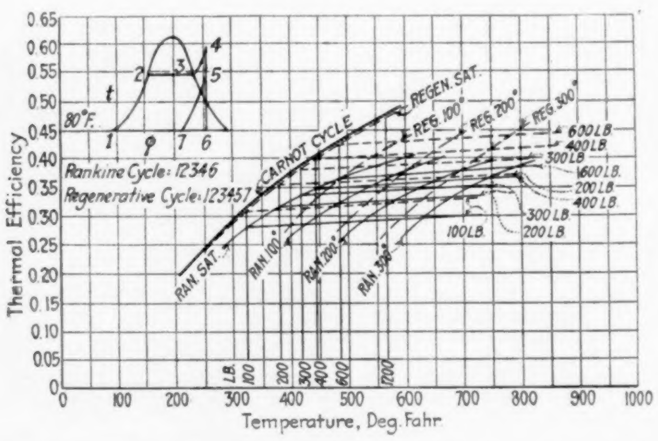


Fig. 1 Theoretical Thermal Efficiency of the Carnot Cycle, the Rankine Cycle, and a Regenerative Cycle, Using Both Saturated and Superheat Values for Ranges up to 1200 Lb. and Superheats of 750 Deg. and Above

of higher pressure and temperature. Practice at this date (1900) may best be illustrated by the work of the Wildwood engine. Since 1900 improvements in steam generators, piping, and prime movers have been made with increasing rapidity, and many modern plants are running on 250 lb. and 200 deg. of superheat, using standard piping and valves with the newer designs of boilers, superheaters, and turbines. Table 1 shows the pressures and economies theoretically possible and attained in a central station, with all the results reduced to British thermal units in the coal per kilowatt-hour of useful work.

TABLE 1 STEAM PRESSURES AND ECONOMIES THEORETICALLY POSSIBLE AND ACTUALLY ATTAINED IN CENTRAL STATIONS

Year	Engine	Pressure, lb. per. sq. in.	Temperature, deg. fahr.	Thermal efficiency, Carnot cycle, per cent	Actual B.t.u. per kw-hr.	Actual overall thermal efficiency, per cent
1770	Newcomen..........	15	212	2.7	416,000	0.82
1810	Watt..............	30	300	9.17	61,000	5.6
1900	Wildwood..........	215	400	20.8	19,200	17.75
1922	Modern............	265	650	35.00	18,000	19.00

Our engineers are now using better and more uniform materials than ever before. Our metallurgical and manufacturing methods have been greatly improved. Copper, wrought iron, and cast iron have been discarded for boiler purposes. Steel and even alloy steel are in common use and their uniformity leaves little to be desired. Certain of the non-ferrous alloys are in common use and play their part in aiding the common security which characterizes modern installations. Copper boilers and 212 deg. maximum temperature gave place to wrought-iron boilers and 30 to 40 lb. pressure with a maximum temperature of 300 deg. The use of steel as a boiler material raised the pressure to 200 lb. and the temperature to 400 deg., while our modern steels allow pressures up to 400 lb. with a maximum temperature of 750 deg. In certain distillation plants temperatures as high as 1100 deg. have been obtained, but the life of the material is short.

Now it is well known that steel when heated to comparatively low temperatures, say, 900 or 1000 deg., loses its strength and becomes unfit to sustain loads, and the heat strains from even moderate heating of 300 or 400 deg. may cause certain deformations of a highly unsatisfactory character. Cast-steel valves have deformed at 750 deg. to such an extent as to render them useless, and the "growth" of ordinary cast iron at temperatures above 450 deg. is known to be destructive; but notwithstanding this the later constructions at 250–300 lb. pressure and 700 deg. maximum temperature are commercial. The first cost is not excessive, repairs are moderate, and the life of the installation is all that can be desired.

Commercial Limits of Pressure and Superheat in the Central Station

What, then, are the commercial limits of pressure and superheat in the central station? In Fig. 1 we have calculated and plotted the theoretical thermal efficiency of the Carnot cycle, the Rankine cycle, and a regenerative cycle, using both saturated and superheat values for ranges up to 1200 lb. and superheats of 750 deg. and above. It will be seen that the chosen regenerative cycle for saturation follows very closely the efficiency of the Carnot cycle, while the Rankine cycle falls below the Carnot cycle increasingly with rise of pressures. The superheat lines for both cycles are nearly parallel and maintain this characteristic over a wide range. The gain from regeneration increases with pressure and is constant for equal superheat. For any final temperature the gain from pressure increments decreases, but the gain from regeneration increases with pressure increments. Thus at 750 deg. final temperature the Rankine efficiency increases from 33.5 per cent to 40.5 per cent with pressure rise from 200 to 1200 lb., while the regenerative efficiency increases from 37 per cent to 48.5 per cent with the same pressure increase.

Fig. 1, dealing with theoretical efficiencies only, does not show the station losses which aggregate around 45 per cent. Grouping the losses, we may say that the generator efficiency is 97 per cent, turbine efficiency 78 per cent, boiler efficiency 80 per cent, leaving for auxiliaries, piping, and radiation 91 per cent, all of which multiplied together give 55 per cent efficiency.

TABLE 2 SAVINGS EFFECTED THROUGH INCREASE IN STEAM PRESSURE

Case	Cycle	Pressure, lb.	Max. temp. deg. fahr.	Theoretical efficiency, per cent	Station efficiency, per cent	Actual efficiency, per cent	B.t.u. per kw-hr.
1	Rankine.....	200	750	33.5	55	18.4	18,500
2	Rankine.....	1200	750	40.5	55	22.3	15,300
	Saving.....			21			3,200
3	Regenerative,	200	750	37	55	20.35	16,800
4	Regenerative.	1200	750	48.5	55	26.7	12,800
	Saving.....			33.3			4,000

Table 2 shows how these figures work out for the above suppositions. The saving by regeneration when using 200 lb. pressure (Case 1 – Case 3) is 1700 B.t.u., and when using 1200 lb. pressure (Case 2 – Case 4) is 2500 B.t.u. Considering the trend of the curves in Fig. 1, on this page, comparatively little is gained by further superheating, but there has been no attempt to go above 800 deg. and the flattening out is much more marked as the temperature increases.

[1] Consulting Engineer, 17 Battery Place. Mem. Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 4 to 7, 1922, of The American Society of Mechanical Engineers. Copies of the paper may be obtained gratis on application. All papers are subject to revision.

Water has its critical temperature at 704 deg. and the critical pressure is about 3200 lb. Pressures up to this limit may therefore be considered, and since oil-still temperatures up to 1100 deg. have been used, we may consider superheat temperatures up to that point. We know that the first allotropic change in steel occurs at about 1300 deg., and 1100 deg. is well below this point. Here, however, we must look into the physical properties of the steels used in power-plant construction.

When steel is heated the first sign of change—a dull red just visible in the dark—appears at about 750 deg. Visibility in daylight begins at about 850 to 900 deg. and a full dark red is attained at about 1100 deg. The full cherry red is attained at the first allotropic change of 1300 deg. Good boiler steels increase in tensile strength up to about 600 to 700 deg. and lose much in ductility, but above 800 deg. the tensile strength rapidly falls off and the ductility largely increases. Cast steels of proper carbon content and suitable for fittings, valves, and turbine construction show the same properties within rather narrow limits. Pipe steels have nearly the same characteristics, but the temperature at which the tensile strength starts to fall is around 550 to 600 deg. This lack of ductility or increase of brittleness at the maximum temperature of use must be compensated for by a larger factor of safety (i.e., increased thickness and weight with higher cost) and a more careful selection of material. But with increased thickness it must not be forgotten that the safe stresses must be correspondingly lowered. The variation of strength of materials with temperature is covered in an appendix to the complete paper.

Variation of Strength of Materials with Temperature

This subject may be considered from five points of view, depending on the conditions under which the materials are to be used.

(*a*) *Boiler Material.* Here we know that the maximum temperature cannot exceed 704 deg., the critical temperature of water, and that the fire side of the tube or drum can only be a few degrees hotter. If 1200 to 1800 lb. per sq. in. be the chosen pressure, the water temperature is 625 deg. at maximum and the fire side will not exceed 725 deg. normally. This temperature is well within the maximum-strength zone, and only care is needed to secure sufficient ductility.

(*b*) *Superheater Material.* The maximum temperature of the inner surface of the tubes may be a little higher than the maximum superheat. The outer temperature depends on the position in the boiler. Radiant-heat superheaters are now commercial where the pressure parts are protected with a heat-absorbing and conducting covering of cast iron. The fire surfaces may be 1400 deg. to 1600 deg. while the inner-wall temperature is as low as 700 deg., but 1100 deg. is comparably easy of attainment. Bare-tube superheaters would have a maximum outside temperature of around 1200 deg., but the life at this temperature is unknown. The maximum safe point may be taken as 800 deg. superheat temperature and 950 deg. outside temperature.

Neither the tube manufacturers nor superheater manufacturers are afraid of these conditions, and I believe they are prepared to guarantee their product under such conditions.

(*c*) *Piping Material.* Under this category the condition is markedly different. The steam side of the pipe is below the maximum temperature of the steam. The outer surface is much lower and the thickness of the material can be increased to compensate for the lower elastic limit of the material. The ductility is improving with temperature increase. Pipe joints are the only serious trouble, and the modified Van Stone joint with the pipe edges welded for tightness is the apparent solution. Experience with this joint has been satisfactory.

(*d*) *Valves and Fittings.* Valves and fittings must necessarily be made of castings, and the low-carbon, open-hearth steel used, while falling off in strength sooner than the worked material used in boiler and piping, has still a respectable elastic limit at 1100 deg. As in the last category, the inside-wall temperature is lower than the steam temperature, with still lower temperatures at the outer wall. But the shape of the casting is all-important. Globe valves of the double-beat or Wanick type can be made with practically no flat surfaces and with two axes of symmetry. Internal pressures do not seriously deform this design, but external strains may cause minor troubles. Throttle valves and marine stop valves are usually of this type and can be kept tight at 750 deg. It is probable that a temperature of 1100 deg. could be safely undertaken with these valves if special precautions were used in the design of the seat, disk, and stem. Flexible-disk, double-beat valves are used in Europe at temperatures in excess of 750 deg.

Gate valves have only one axis of symmetry and flat surfaces of considerable size. Here seat and disk troubles are encountered at temperatures above 700 deg., and it may be some time before the manufacturers can guarantee a tight job at the higher temperatures. This type of valve is peculiarly sensitive to outside strains tending to deform the seats and disk.

(*e*) *Turbine High-Pressure Ends.* Pressures can make little difference here as the high-pressure parts are comparatively small and without doubt the pressure will be reduced 50 per cent in the first nozzle. There need be no high-pressure stuffing box, so that the highest pressure to be packed against will be about half the maximum. Temperature strains will be the only thing that need be considered, and the expansion will reduce the superheat in the first-stage nozzle to a workable value, which is 750–850 deg. It is to be noted that steam-chest or nozzle-box troubles have been the only prominent troubles where 400 lb. and 750 deg. superheat have been tried out, and it thus appears that a proper design will obviate most of the trouble. Cast or forged steel must be the material used.

In general, the turbine designers say that 1200–1500 lb. pressure has no terrors for them and can be used when desired. They can supply the apparatus. Temperatures are more troublesome and no one apparently cares to go much above 700–750 deg. at the present time. Superheater and valve materials at present seem to be the deciding factor in the use of high pressures and temperatures, and there is apparently very little which careful design and the selection of proper materials will not overcome.

Only a portion of the central-station installation is affected by high pressures and temperatures, especially where electric auxiliaries are used. The boiler and piping system and prime mover cover the entire list, and in the usual central station this has represented about 40 per cent of the entire installation cost. Latterly, with the larger station the percentage is around 30, and may be taken at 25 per cent for the newer and larger stations of which Hell Gate and Calumet are types. If the station cost be taken at $100.00 per kw. as an average figure this portion of the installation has cost $25.00, and at 15 per cent the fixed charges are $3.75 per year or on 5000 hours' use 0.07 cent per kw-hr. What, then, will be the extra cost of this apparatus when designed for higher pressures and temperatures? Standard boilers today can be bought up to 275 lb. pressure; 300 lb. necessitates thicker plates and tubes, and prices advance accordingly. 400-lb. boilers have been purchased recently and 500-lb. boilers have been built. Flash boilers of the Serpollet and De Laval types using pressures in excess of 1200 lb. and coil boilers of the Herreshoff type using equally high pressures have been built as experiments or in toy sizes as for automobile work or for high-speed launches. Schmidt's water-tube boiler working at 900 lb. has been run 14,000 hours with marked success. Boilers for 400 lb. pressure have been offered at about 50 per cent increase in price and 1200-lb. boilers have been figured at a 100 per cent increase in price.

Turbine designers are at work on designs arranged to utilize higher pressures, but higher temperatures seem more troublesome to them. I have no estimate, but we can safely apply the same percentage increases of price to the turbine that obtain with the boiler. Steam piping decreases in size with increasing pressure, so much so that it is doubtful if a 1200-lb. steam line would cost more than a 200-lb. line of the same capacity. The volume of high-pressure steam at 1100 deg. maximum temperature is quite uncertain, but the chances are that our figures are not more than 10 per cent from the truth.

Summary

We may then summarize as follows:

a Pressures up to 1200–1500 lb. at least are commercial and may be attained without serious difficulty.

b Temperatures for the present are commercial up to 700–750 deg., which should not be exceeded until our materials for valves and superheaters are improved. More extended experience is nec-

essary before the range of 800 deg. and over is attempted in a commercial installation.

c With the completion of the Steam Table Research it will be possible to calculate accurately just where the possible limits of economy in pressure and temperatures may be located. At the present time the uncertainty of all values above 200 lb. pressure and 4000 deg. fahr. temperature render most of our calculations of only academic value.

d There still appears to be more economy in a closer study of operation and construction losses—resulting in improving the efficiency of central stations installed in accordance with the present accepted canons of design—than in the attempt to widely increase the temperature range of our heat cycles. While we may save 400 B.t.u. per kw-hr. by using a regenerative cycle and increasing pressure and temperature, it should be possible to save nearly as much by a reduction to the lowest limits of the heat losses which we know exist in our present installations.

Savings of Regenerative Cycle

In Table 3 we have given for 700 and 1000 deg. maximum temperature and for four pressures the theoretical efficiency of the three cycles used, the practical efficiency of the Rankine and regenerative cycles, and the savings per kilowatt-hour for all conditions over the Rankine cycle at 200 lb. and 700 deg. maximum temperature in B.t.u. and lb. of coal of 13,800 B.t.u. content.

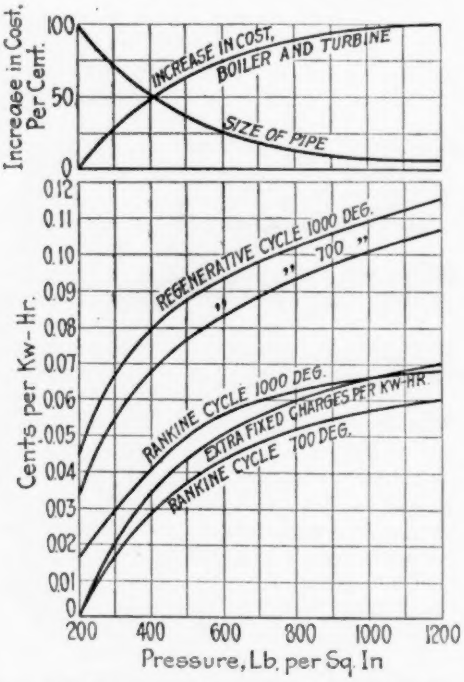


Fig. 2 Savings in Cents per Kilowatt-Hour for All Conditions Over the Rankine Cycle at 200 lb. and 700 Deg. Maximum Temperature, Based on $6.00 Coal

In Fig. 2 these savings are plotted in cents per kilowatt-hour on the basis of $6.00 coal, together with the extra-fixed-charges curve. At the top of the figure are two curves showing the percentage increase in cost of boiler and turbine and the decrease in size of pipe required for a given quantity of steam. It will be seen that the extra fixed charges are always greater than the coal saving for the Rankine cycle (ordinary operation) at 700 deg. maximum temperature, and that the additional gain for the 1000 deg. maximum temperature barely exceeds the additional fixed charges. We cannot then expect much from increasing pressures and the ordinary methods of using steam. Increasing temperatures help to some extent, but not enough to be attractive, since the saving is nearly all used up by the additional fixed charges.

With the regenerative cycle the results are much better and useful savings are indicated, increasing considerably with pressure and slightly with temperature. It is evident that some such regenerative cycle must be used, but the rewards from increasing temperature are not commensurate with the costs. Many regenerative cycles are possible, but the one used shows nearly the maximum economy. Such cycles need many heat interchangers and a number of separate feed pumps for the close approach to theoretical figures. Indeed, Thurston and Stanwood[1] in 1899 pointed out that with an infinity of heaters and pumps the Carnot efficiency might be equaled. So far, however, four or five stages have been the ultimate practical application, and not more than three have stood the commercial test. It would appear that considerably better design must be put in the apparatus if many steps are proposed, and also that more consideration must be given to the operating difficulties.

TABLE 3 SAVINGS IN COAL

Pressure lb. per sq. in.	Superheat temp., deg. fahr.	Carnot effy.	Reg. effy.	Rank. effy.	Reg. × 0.55	Rank. × 0.55	Reg. B.t.u.	Rank. B.t.u.	Saving over R. 200 lb. 700°, B.t.u. per kw-hr. Reg. C.	Rank. C.	Saving in lb. coal per kw-hr. (13800 B.t.u.) Reg. C.	Rank. C.
200	700	53.5	37	33.4	20.3	18.35	16820	18620	1800	—	0.13	—
400	700	53.5	41.2	36.3	22.6	19.95	15100	17120	3520	1500	0.255	0.109
600	700	53.5	43.5	38	23.9	20.9	14300	16350	4320	2270	0.313	0.1645
1200	700	53.5	47.5	40	26.1	22	13100	15500	5520	3120	0.40	0.226
200	1000	63	38	35	20.9	19.25	16350	17750	2270	870	0.165	0.065
400	1000	63	42.8	37.6	23.5	20.7	14500	16500	4120	2120	0.299	0.1535
600	1000	63	45	39.5	24.7	21.7	13820	15720	4800	2900	0.348	0.21
1200	1000	63	49	41.5	26.9	22.8	12700	14970	5920	3650	0.43	0.257

Acknowledgment

Much of the work in connection with the preparation of this paper has been done by W. S. Morrison and M. A. Guigou, members of the Society. An appendix dealing with the properties of metals at high temperatures and which accompanies the complete paper is the work of Mr. Morrison; most of the calculations have been done by Mr. Guigou and the drawings made by Mr. H. H. Worth, Junior Member Am.Soc.M.E. Credit should also be given to a number of my friends and associates who have criticised the paper during its preparation.

When the plant of the Buffalo General Electric was put into operation in 1916 and 1917, it represented the high-water mark in steam pressures and temperatures in large power-plant practice in this country. This plant attracted international attention, and although at that time it was predicted by some authorities that five hundred or six hundred pounds pressure was a probability of the near future, there are still many large plants that seem to favor pressures of about three hundred pounds and a total temperature of around six hundred degrees. There are a few exceptions, but in the main the operator has not taken kindly to pressures and temperatures much above these, as it has been found one thing to design and construct a plant for high steam pressures and temperatures and an entirely different thing to operate the plant and make it give reliable service. However, many of the earlier operating difficulties have been overcome and, after what might be considered a pause at steam pressures of about three hundred pounds, the tendency is again to go to higher pressures. A notable example of this is the new plant of the Public Service Company of Northern Illinois, at Waukegan. These boilers, which will operate at four hundred pounds pressure, are of a new design especially adapted to high pressures in large units. Although this is the first time that pressures in excess of three hundred fifty pounds have been employed in large plants in this country, marine-type boilers have been built for six hundred pounds but they have been small-sized units. The new boiler is a somewhat radical departure from the standard designs that have been employed in large sizes for stationary work up to three hundred fifty pounds.

An increase in Rankine cycle efficiency is obtained with an increase in pressure up to about eighteen hundred pounds, after which it begins to fall off. However, this increase in efficiency is not in direct proportion to the increase in pressure. With steam at a constant temperature of seven hundred degrees there is a gain of about three and one-half per cent between one hundred fifty and three hundred fifty pounds. From this point the curve begins to flatten out, and the gain between three hundred fifty and six hundred pounds is only two per cent, with an additional gain of two per cent by carrying the pressure up to one thousand pounds.—*Power*, Sept. 12, 1922, p. 424.

[1] Trans. Am.Soc.M.E., vol. 21, pp. 192 and227.

The Preservation of Decaying Wood Roofs

General Theory of Wood Decay—Methods Employed in Preserving Wood Roofs—Economic Considerations in Prolonging the Useful Life of Repaired Roofs

By WENDELL S. BROWN,[1] PROVIDENCE, R. I.

RAPID development in industry, like the accelerated progress of civilization, is often and perhaps inevitably accompanied by certain afflictions and disorders. And in the last quarter century one of the disturbing conditions which has arisen and which is demanding increasing attention in certain sections of the industrial world has been the serious decay of wood roofs.

Now a roof is a cover of a building, according to one dictionary definition. But unfortunately, since the advent, in buildings of home-made weather, either in the form of artificially high or naturally high relative humidities—due to some necessary process—a roof must have other attributes than covering only, if it is to act as a real shelter. For, under certain conditions instead of constituting a protection, the reverse is true, and the roof becomes a positive source of trouble. This happens when the formation of condensation (commonly called sweating) on the ceiling is so rapid as to cause dripping into the room below, with consequent annoyance to the occupants and often serious damage to machinery, building, and materials in process.

Happily, it is a comparatively simple matter, by adopting suitable insulation, to prevent the formation of condensation on, and dripping from, the under surface of the roof, for any usual condition encountered. That is, theory and laboratory tests, authenticated by actual installations, have provided accurate methods for rationally designing many different types of roofs to meet varying requirements as to relative humidity and temperature carried in the room below.[2]

But with respect to wood roofs, prevention of visible condensation is only part of the story, for the reason that cracks between the plank afford a more or less direct channel by which warm, moist air from the room below reaches the roofing paper, which latter is practically at the temperature of the outside air. If this temperature is below the dewpoint of the said contacting room air, precipitation of moisture or condensation results; which means nothing more nor less than that the first ply of roofing paper and the top of the wood roof itself are saturated with water during the greater part of the heating season in temperate or colder climates. Laboratory tests and the experience of those who have removed old mill roofs bear this out.

In fact, this rot-inducing feature is the outstanding bugbear and cause of excessive mortality in wood roofs of those manufacturing buildings—such as textile mills, finishing plants, paper mills and food factories—which utilize or by nature house high relative humidities. The damage is enormous—greater than generally realized—amounting to hundreds of thousands of dollars annually in building material alone, besides occasioning often more serious losses in production and general derangement. Many such unenviable records exhibit useful roof lives as short as three years, with a possible average of ten years and a maximum of twenty-five years, depending upon the severity of atmospheric conditions within and without the building, and the species and quality of lumber used.

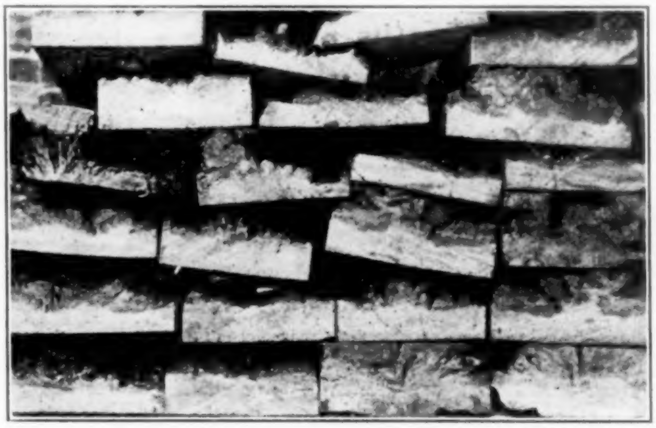
Notwithstanding the subject under consideration is the preservation of old wood roofs, it would be remiss not to admit that some of them are not worth saving. The correct determination of whether or not a roof is worth saving lies in a full consideration of the problem from a purely utilitarian viewpoint, and the paper aims to indicate general principles by which this often debatable question may be settled, and also to describe one method by which the desired result has apparently been attained.

General Theory of Wood Decay

The almost exclusive cause of decay in wood is the destroying action of certain fungi, of which there are several varieties. These, however, in order to accomplish their destructive work, must have a favorable environment, which, in addition to suitable media in the form of wood fiber from which their food supply may be obtained, consists of the proper amount of moisture, temperature and air supply. There are two general classifications of such fungi:

1. The "dry rot" group, thriving in a comparatively narrow range of cool to moderate temperatures and not requiring great amounts of moisture;
2. The "damp rot" or "mill roof" group, thriving over wider and generally warmer temperature ranges, but requiring relatively large amounts of moisture for their normal development.

As indicated in the name, we are concerned particularly with



(Photo by F. J. Hoxie)

Fig. 1 Showing Typical Decay in Roof Plank Starting at Top Surface

the second group, which requires either air at practically 100 per cent relative humidity or a free supply of water in its liquid state. Incidentally, since air is necessary for fungus growth, the presence of water to such an extent as to prevent admission of air to the wood cells is fatal.

Wood roofs over buildings housing ordinary temperatures and humidities lack only one requirement to make them excellent media for infection and decay from the second group. This one deficiency is moisture, which, in the case of those special roofs under consideration, is supplied by condensation.

There are perhaps half a dozen kinds of fungi most commonly found attacking mill roofs, and the limits of temperature and moisture most favorable to their development vary somewhat with the species. Many investigators, both here and abroad, have devoted considerable study to the classification of fungus diseases, and the conditions affecting their germination, dissemination, and subsequent development and viability. For instance it has been found that the temperature at which most of the mill-roof fungi grow and spread lies between the approximate limits of 35 deg. fahr. and 110 deg. fahr., the optimum limits for development being considerably narrower than the above—approximately 75 deg. fahr. to 100 deg. fahr. Alternate wetting and drying is destructive to the spores cast off by certain fungi; and some varieties develop best in darkness, while others require diffused light, but not direct sunlight.

Ordinarily, decay in roof plank starts at the top surface (see Fig. 1), especially if the first ply of paper is dry sheathing not mopped

[1] Engineer, F. P. Sheldon & Son. Mem. Am.Soc.M.E.

[2] See original paper on this subject by F. P. Sheldon & Son, Engineers and Architects, Providence, R. I., entitled Experiments to Determine the Relative Effectiveness of Various Types of Roofs in Preventing the Formation of Condensation upon their Under Surface, read before the National Association of Cotton Manufacturers, 102nd Annual Meeting, Boston, Mass., April 25, 1917.

Presented at the Springfield Regional Meeting of The American Society of Mechanical Engineers, Springfield, Mass., September 25-27, 1922. Slightly abridged.

down. Sometimes, however, infection seems to get a foothold first just above the tongue and groove or spline and progresses more rapidly within the central portion of the plank lying between the two extremes of moisture.

In sawtooth buildings, valley plank usually decay first, this being generally traceable to one or more of the following contributory causes:

a Since sawtooth lighting areas ordinarily face approximately north, the valleys are considerably shaded by adjacent sawteeth, which latter intercept the warming effect of the direct solar rays when the sun is at low altitude during the heating season.

b Often heating coils are located solely under the glass or at some distance up the wooden back of the sawtooth, leaving the valley portion chilled, and subject, therefore, to excessive condensation.

c There is a tendency for moisture or condensation to drain toward the low point of the roof.

An indication of the comparative extent to which rotting has progressed in various portions of a roof may often be had from the brown extractive matter deposited in rusty streaks on rafters

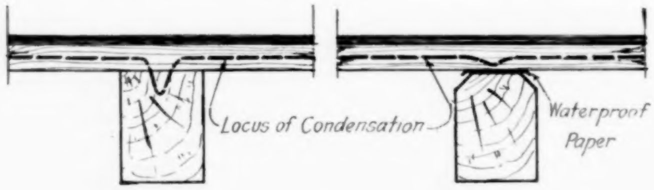


FIG. 2 SHOWING HOW LOCUS OF CONDENSATION DIPS OVER A BEAM OR RAFTER

FIG. 3 SHOWING HOW LOCUS OF CONDENSATION MAY BE RAISED BY CHAMFERING CORNERS OF BEAM OR RAFTER

and plank. Decay is usually greatest in plank and beams at bearings because, due to the additional insulating properties of the supporting members, the locus of condensation[1] dips as indicated in Fig. 2. Tops of roof rafters and girders rot first—usually for the same reason; and other conditions being equal, decay is more active in the vicinity of ventilators, cold conductor pipes, etc.

But the quality of lumber as well as species or variety is also a vital factor in its longevity, and variations in the former often tend to upset too close generalizations concerning the placement of decay. For instance, three years ago two bays of roof plank and one roof rafter in a Rhode Island weave shed were replaced with entirely new but unsuitable material having a high percentage of sap wood. The plank is already more than one-half rotten and is in a worse condition than the remainder of the roof which is thirteen years old.

METHODS EMPLOYED IN PRESERVING WOOD ROOFS

Taking up the question of treatment, there seems to be no practicable means of preventing exposure to infection, or of eliminating rot-inducing conditions, as far as temperature alone is concerned.

For new wood roofs antiseptic treatment is possible, and several processes, such as creosoting and kyanizing, may be adopted for the preservation of plank. One creosoting concern has recently introduced a priming paint and claims that it is not penetrable by creosote, thus making possible the application of white ceiling paint directly without sheathing. Girders and beams may be made of steel, but if untreated timber is used the upper edges of beams may be chamfered and covered with a layer of waterproof paper, as shown in Fig. 3. Chamfering tends to raise the locus of condensation, and the paper still further assists in keeping the top of the beams dry.

In the case of existing roofs the treatment must of necessity be ameliorative rather than preventive or curative; and it should be clearly understood that the term "preservation" is meant to indicate merely the economic postponement of ultimate roof renewal and not the attainment of permanency. Briefly, the treatment consists in removing from the fungus its water supply by preventing condensation so far as is practicable. And condensation is decreased by insulating the outer roof surface, the extent of inhibition depending upon the amount of insulation.

There are certain inherent limitations to this treatment which prevent the full attainment either of water-supply removal or of sterilization. First, it is impracticable on account of excessive initial expense to lay enough insulation to wholly prevent condensation within the roof plank even in moderately cold winter weather. Second, certain fungi are suspected of having a faculty—once they are well developed—of manufacturing water to a limited extent through a decomposition of the wood structure itself, provided said decay is deep seated and protected from too rapid evaporation. That is, water in its liquid state is not absolutely necessary for their maintenance. The important characteristic of this treatment is therefore a retarding action accomplished by making the environment as unfavorable as practicable.

Top insulation has the effect of moving the plane or locus of condensation for any given set of atmospheric conditions nearer the outer surface of the plank than before, and in mild weather of

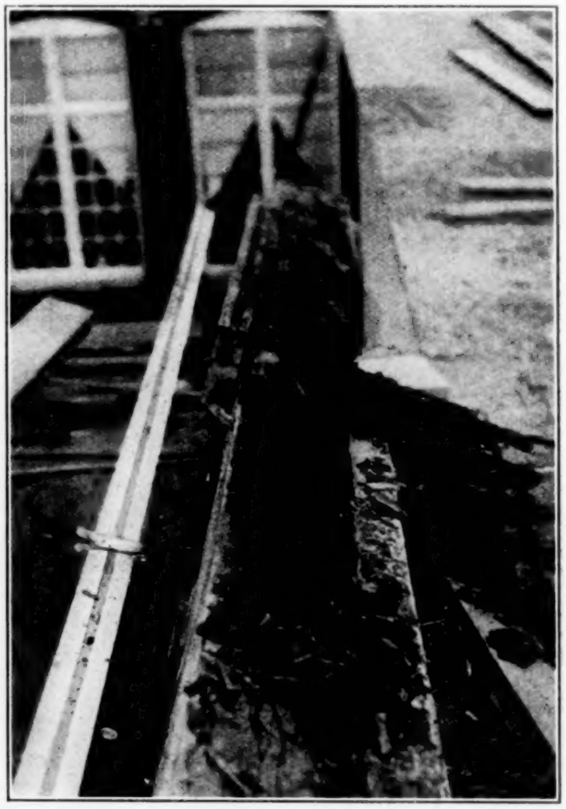


FIG. 4 TYPICAL DECAY IN YELLOW-PINE GIRDERS

eliminating it entirely. In other words, the rate of condensation is reduced, as is also its duration, resulting in checking inroads of disease already established, and also in lessening the susceptibility of timber to further infection.

Insulation should be in sufficient amount to entirely prevent condensation on the under side of the roof in most severe weather, and if wood, should itself be antiseptically treated. Creosoted yellow-pine boarding nailed to furring strips has been found to be an economical type of insulation. Cheap, open-grained lumber, preferably sap wood, should be used, since it readily absorbs the necessary amount of wood preservative. By laying it over furring strips, additional and especially effective and inexpensive insulation in the form of an air space is obtained. This type of insulation also adds materially to the strength of the roof plank; in fact, it may be made thick enough to support the old plank if the latter have become seriously weakened, and the importance of not interrupting production is paramount. The old plank, where dangerously decayed, would then be spiked to the new plank from below.

[1] "Locus of Condensation" may be defined as a plane whose temperature equals the dewpoint temperature of the contacting room air. Below this plane no condensation takes place; above it, condensation occurs with increasing activity as the top surface of the roof is approached.

In order to prevent entrance into the new insulating air space of warm, humid air from the room below (and therefore condensation which would otherwise occur within the upper insulating deck and would drip upon the lower untreated plank), it is necessary to have a waterproof membrane between the old roof and the new insulation. The old roofing paper may be left intact and used for this purpose, if practical. On one large weave shed the new insulation was laid directly on the tar-and-gravel roof without removal of gravel, except what could be easily brushed off. If considerable structural renewal becomes necessary, however, it will generally be found advisable to remove the roofing paper entirely, and after necessary replacements have been made, to lay down a two-ply roof over the same before applying the insulation.

An economic consideration of the question invariably shows that the additional insulation saves enough heat to help very materially in meeting fixed charges on the initial cost of installation. This is illustrated later. Furthermore, dripping from the ceiling, which may have been experienced previously, will be stopped.

Sometimes it is advisable to rearrange the heating system so as to obtain a more uniform distribution. In sawtooth buildings a portion of the heating surface should be placed under the plank and a portion under the glass, the object being to obtain a balance (that is, as little circulation of air as possible directly under the sawteeth) and thus maintain a uniform and somewhat higher temperature here, without, however, increasing the room temperature on the working plane. The effect is to decrease still further the rate of condensation within the old roof and the number of days of its occurrence during the year.

The most recent installation with which the author is familiar was completed a month ago under the direction of F. P. Sheldon & Son, Engineers and Architects, with which firm he is connected. The building is a sawtooth weave shed have a projected roof area of 116,000 sq. ft.

The weave shed is now twenty-three years old, and during the past ten years considerable portions of the roof have been replaced. For humidity, during approximately the first twenty years, it depended upon the admission of moist basement air through belt holes in the floor at each individual loom, the basement being traversed by a canal and containing more or less standing water. Recently,

Fig. 5 General View of Contractors' Plant

mechanical humidifiers were installed with the intention of maintaining a more constant relative humidity (approximately 75 per cent) than was before possible. The humidifier installation probably has accelerated roof decay somewhat, but, on the other hand, the basement may now be properly ventilated, and the present ravages of decay in floor plank, beams, and columns prevented, or at least materially retarded.

Sixty per cent of the roof plank was so rotted as to need renewal. Two per cent of the 6-in. by 12-in. yellow-pine rafters, and 25 per cent of the 11-in. by 14-in. yellow-pine girders were replaced for the same reason. The good condition of the rafters is worth noting and is doubtless due in part to their narrowness, which tends to prevent any marked dip in the locus of condensation—see Fig. 3.

The technique in this particular instance was briefly as follows: The insulation consisted of $^7/_8$-in. square-edged, creosoted yellow-pine boarding nailed on $^7/_8$-in. creosoted furring pieces, resulting in a $^7/_8$-in. air space between the old roof and the new boards. The lumber was treated on the job by the hot-dip process, being unloaded direct from the cars to a storage pile within 40 ft. of the creosoting tank, which latter was of steel, 20 ft. long, 7 ft. wide and 5 ft. deep, and had ample capacity for 3000 ft. B. M. of lumber used daily. Boards were stuck with 6-ft. pieces every six boards and were divided into two sections for a given charge, each section fastened with a cable sling. An A-frame derrick (Fig. 6) made of two 50-ft. telegraph poles was used for lifting the sections into the tank. It also served in removing batches from the tank and hoisting them to the weave-shed roof. Heavy timbers were used to ballast the lumber being treated, and these were taken to and from the tank on a carriage moving on rollers, and were lifted from it by the derrick. A batch, after being lifted out of the

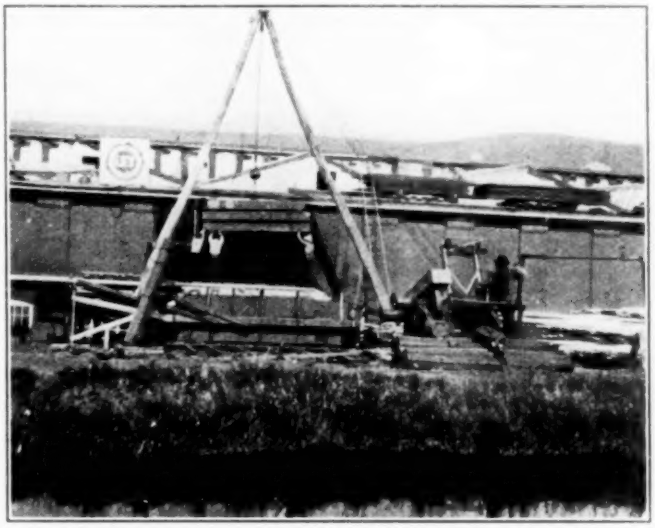


Fig. 6 View of Derrick and Creosoting Tank

hot creosote, was held over the tank and allowed to drain for three or four minutes. It was then hoisted to the roof, after which practically no more dripping occurred; the partial vacuum set up by the air and steam in wood cells, cooling, contracting, and, therefore, sucking in the excess surface oil.

The creosote oil used on the job was furnished in a tank car placed on a siding some 300 ft. from and considerably above the creosoting tank, thus allowing a gravity flow in the pipe line connecting the two. Make-up oil was added each time a batch was removed, except that toward the end of the creosoting process, after all the oil had been placed in the tank, the amount of lumber per batch had to be gradually reduced. During treatment the oil was held at a temperature of about 230 deg. fahr. by means of high-pressure-steam coils having a total heating surface of 270 sq. ft., placed in the bottom of the tank.

The use of wet or unseasoned wood was apparently not detrimental, except for the fact that a longer treatment was necessary in order to insure thorough penetration by first boiling out the entrained water.

The creosote oil used was a modification of Grade 1, American Railway Association Specification, having a specific gravity at 59 deg. fahr. of at least 1.08, and giving, when distilled, no distillate below 392 deg. fahr., not more than 1 per cent below 410 deg. fahr., and not more than 10 per cent below 455 deg. fahr.

The penetration was quite thorough, the amount of oil used averaging 9.4 lb. per cu. ft. for a 20-hour treatment. The creosote cost \$0.29 per gal. delivered, which, reduced to a board-measure basis, added \$0.022 to the unit lumber cost of \$0.03, and made a total of \$0.06 per board foot for treated boards—labor and overhead for treatment included, but not laying. The labor of laying on roof amounted to about \$0.02 per ft. B. M.

Where plank were rotted at bearings, but fairly sound elsewhere, new bearing strips were spiked to each side of the rafter for necessary support.

Not more than one sawtooth for half its length was opened up at any one time with consequent interruption to only that machinery under this particular section. This usually amounted to less than eighty looms for a period not over nine or ten hours.

Economic Considerations in Prolonging the Useful Life of Repaired Roofs

Consideration of the problem from the standpoint of economics shows, for this particular building, if the given insulation prolongs the useful roof life no more than *five* years, that it was warranted and preferable to an entirely new durable roof. Each additional year of life is therefore a net gain, as is also the very real and important (but in this case uncapitalized) saving due to substantially postponing the period in which greater interruption to manufacturing, incident with entirely new roof construction, would occur. The solution was based on the following approximate assumptions made after the necessary study of existing conditions:

1 Regardless of building decay, the felt-and-slag roof, on account of its age and condition, would have required replacement within one year at an estimated cost of $17,000.

2 If decayed members in need of immediate renewal were to be merely replaced by new, without the insulation feature, it was estimated that equal replacements would again be necessary within fifteen years.

Problem: Determine the minimum number of years by which the given insulation must prolong the useful life of the repaired roof in order to prove a financially sound investment, and preferable at this time to an entirely new durable roof.

a The cost of the project was approximately as follows:

Insulation, i.e., creosoted plank in place, including extra two-ply waterproof membrane	$18,000
Felt- and -slag roofing	17,000
Necessary renewals of plank, rafters, and girders, removal of old roofing, painting, etc.	28,000
Total	$63,000

b The minimum cost of an entirely new and durable treated wood roof on yellow-pine rafters and steel girders, including painting, complete erection, etc., was estimated at $110,000.

Working out several trial examples, it is found that the said insulation in order to be justified should add at least *five years* to the useful roof life. Sample computations follow.

(1) The approximate 20-year cost of the repaired roof *with insulation* (that is, the cost over its augmented useful life of 15 + 5 = 20 years) may be calculated as follows:

Initial cost (wholly depreciated)	$63,000	
Yearly interest at 6% = $3,780 having a value in 20 years if compounded annually at 6 per cent of	139,000	
		$202,000
150 tons of coal saved annually at $7 per ton = $1050, having a value in 20 years if compounded annually at 6 per cent of		39,000
Total 20-year cost		$163,000

It is worthy of note that the insulation saves annually in coal 1,050/18,000 or 6 per cent gross of its cost and vitally affects the computations by reducing the number of years by which the said insulation must lengthen the roof life in order to be justified.

(2) The approximate comparative 20-year cost of repaired roof *without insulation* is obtained as follows:

Cost of repairs good for 15 years and then wholly depreciated, $17,000 for roofing plus $28,000 for replacements [see (*a*) above]	$45,000
Yearly interest at 6 per cent = $2700, having a value in 20 years if compounded annually at 6 per cent of	99,000
Cost of equal repairs 15 years hence (probably reduced to $30,000), depreciation at 5/15	10,000
Yearly interest at 6 per cent = $1800, having a value in 5 years if compounded annually at 6 per cent of	10,000
No coal saved	......
Total 20-year cost	$164,000

(3) The approximate comparative 20-year cost of a new and durable roof having an assumed life of forty years is obtained as follows:

Initial cost, $110,000, depreciation at 20/40	$55,000	
Yearly interest at 6 per cent = $6600, having a value in 20 years if compounded annually at 6 per cent of	242,000	
		$297,000
100 tons of coal saved annually at $7 per ton = $700, having a value in 20 years if compounded annually at 6 per cent of		26,000
Total 20-year cost		$271,000

Conclusion

While it is realized that the foregoing assumptions concerning future prices are conjectural, there is apparently ample margin in the result to show the described treatment to be, in this case, an economical procedure. This factor is especially emphasized when the avoidance of serious interruption to production, which would have attended entirely new construction, is considered; as well as the fact that dripping from the ceiling, which occurred previously during severe winter weather, is prevented.

Several other decayed wood roofs have been similarly insulated within the past three or four years with apparently beneficial results, so that this treatment has passed beyond the purely theoretical or experimental stage.

It is easy for an engineer to recommend sweepingly entire roof renewal with more permanent material, such as concrete, treated plank, redwood, etc., as the only real satisfactory solution of a given problem, but the correct answer is ordinarily determined only after careful analysis and evaluating and balancing every factor pertaining to each individual case. Each situation has its own especial features which should be critically examined; and to an executive considering ultimate costs, the question of maintaining production is often of greater weight than building economics pure and simple.

The tremendous damage caused by "damp rot," which is progressing insidiously in many industrial plants today, should be brought to light and more fully realized. In some brick buildings with wood roofs disintegration has occurred amounting in three years to one-quarter the value of the structure; other buildings entirely of wood have been practically a total loss above the foundations in the same time. Even less rapid depreciation instanced in the nearer normal example given has more than a merely local effect. Besides handicapping the manufactory itself, and being reflected in the cost of goods to consumers, such losses must ultimately have an appreciable effect upon international trade, and are intolerable if this nation is to enter into forward-looking competition in world markets. Plainly, damp rot constitutes one affliction of which our modern industry must purge itself if the United States is to play its rightful part with increasing service as a great vital and industrial nation.

A wood preservative new in this country but used in Europe and particularly in Belgium for a number of years is aczol, which is composed of ammonia, copper, zinc and phenol. All of these component parts have been used to a greater or less extent in wood preserving work, but the novelty of this compound lies in the fact that the inventor has succeeded in producing it in soluble form. It is entirely soluble during impregnation and precipitates while the wood is being permitted to dry in the air. The drying causes the evaporation of the ammonia, which simply acts as a carrier of the other ingredients. The phenolic salts of copper and zinc become firmly imbedded in the wood fiber—in fact the sap and ligneous material is soluble in the solution and this liquid is replaced by the precipitated salts.

The impregnation of wood with creosote is accomplished by placing the wood in a large airtight vat. The air is then pumped out to as high a vacuum as possible and the heated creosote is put in under pressure. With aczol the process can be conducted without the use of vacuum and without heating the solution. Wood impregnated with aczol is much stronger than that done with creosote, due, probably, to the cementing action of the salt in and around the wood fiber. It is clean, dry, odorless, and fire-resisting, and can be tooled and worked exactly as untreated wood.

The material is manufactured in rather concentrated form and is diluted—six parts of the product to ninety-four parts of water—in the field.

Records of the use of wood impregnated with aczol have been kept in Belgium for the past decade. Coal-mine operators testify that "acxolated" timber has remained in its original sound condition for eight years. It has also been used successfully on wood paving and in railroad ties, where the rotting is extremely rapid, especially in some climates. It is predicted by a number of competent men that the use of aczol will rapidly displace that of creosote because of its greater durability and greater ease of handling.—*Chemical and Metallurgical Engineering*, Sept. 6, 1922, p. 509.

Spherical Gears

By CHARLES H. LOGUE,[1] SYRACUSE, N. Y.

The basis for a study of all gears whose pitch surfaces are in rolling contact is found in the study of the bevel gear. By acquiring this point of view, not only are the elementary features of bevel-gear design brought out and applied to spur gears, but also the real connection between the two types is shown. This is essential to a complete understanding of either. The author has specially endeavored to point out the necessity for a difference in the design of the teeth heretofore not considered, and to present the entire matter in the simplest possible manner.

THE tooth action of all gears whose pitch surfaces roll upon each other is developed upon the surface of a sphere, within which these pitch surfaces are enclosed. A study upon this basis is essential to a complete understanding of the action of both spur and bevel gears.

To illustrate, let us begin with a pair of miter gears whose pitch radii are 1 in., and which will operate at a shaft angle of 90 deg.; the apex distance (spherical radius) being 1.4142 in. Now consider a series of spherical enlargements, maintaining the same pitch radii for the gears. It will be noticed, as this enlargement progresses, that the angle of the axes is gradually reduced and that the gears very soon assume the appearance of spur gears, the pitch cones gradually merging into cylinders, which are attained when the radius of the enclosing sphere, or the apex distance, reaches infinity. Practically, we may thus develop cylindrical pitch surfaces within the range of a good-sized drawing board. See Fig. 1.

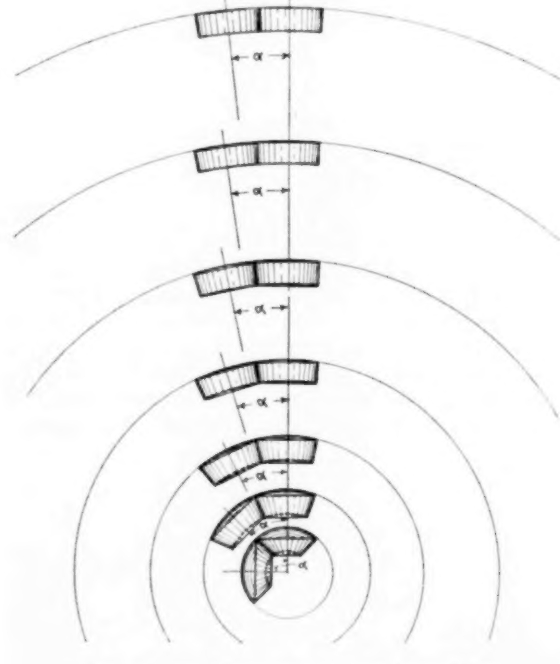


Fig. 1 The Evolution of the Spur Gear
(Angle $\alpha = 0$ when radius of sphere is infinite.)

Another way in which this fundamental may be illustrated is by considering the gradual enlargement of the radius of the crown gear, or our molding element. The pitch radius of the crown gear is the radius of the sphere, and its pitch surface is enclosed by one-half of the complete sphere. This pitch surface is a plane through the great circle, known as the "crown surface." Fig. 2 shows the nature of the engagement for a continuously enlarged crown gear with a pinion, the spherical radius being increased successively from a to b and from b to c. When the radius of the sphere is increased from a to b the angle of axes is reduced from A_1 to A_2, and then to A_3 by the increase to c. It is apparent, when an infinite spherical radius is considered, that the angle of axes A will be 90 deg. The angle of axes being 90 deg. and the ratio of reduction infinity, spur and bevel gears are identical.

Fig. 3 shows conical pitch surfaces within the sphere. The center of this sphere must be the common intersection of these conical surfaces, or the intersection of their axes. The angle of axes may be altered as desired, when new pitch cones will automatically form as shown in Fig. 4. By again considering a sphere whose radius is infinity, it will be apparent that an angular adjustment of the axis, as illustrated by Fig. 4, corresponds to a change in the distance between centers for spur gears. For spur gears the pitch diameters of both gear and pinion automatically form through a point which is the intersection of the line of action and the line of centers. Consider, for spur gears, that this occurs upon the surface of a sphere whose radius is infinity and apply this same development upon the surface of a sphere whose radius is the apex distance for bevel gears such as shown by Fig. 4. A drawing board for the development of tooth action should be a wooden sphere whose radius is the apex distance. For a pair of bevel gears of 49/11 ratio and 5 diametral pitch, operating at 90 deg., this "drawing board" would have a radius of 5.022 in. For the same gears operating at a zero shaft angle, the regulation drawing board is properly employed, on which we may also lay out a pair of gears whose angle of axes is 90 deg. when the ratio of reduction is infinity, or any pair of gears whose pitch surfaces are enclosed by a sphere whose radius is infinity. It will be noted that for any pair of gears enclosed by a measurable sphere, all tooth parts are properly expressed by angles, the only lineal dimension being the radius of the sphere.

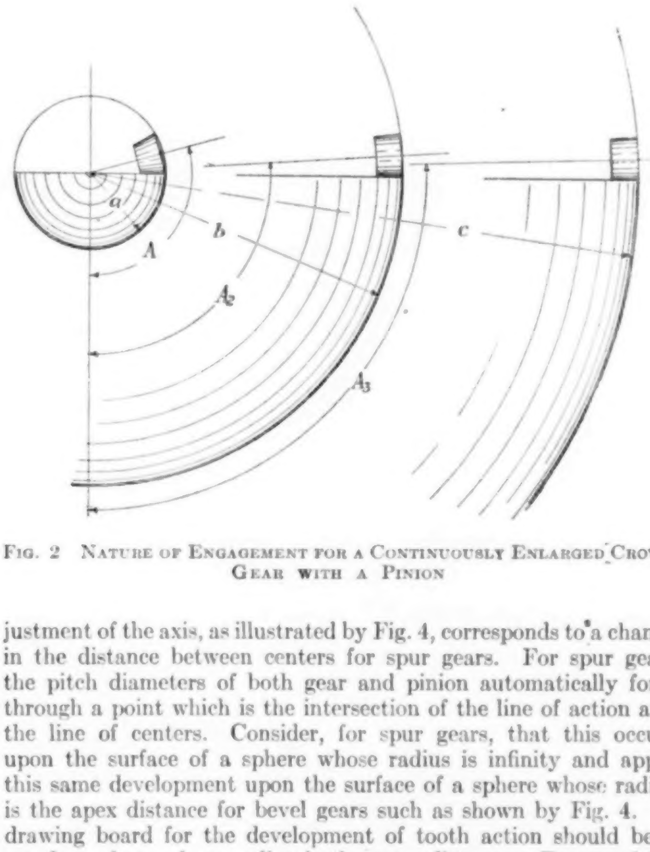


Fig. 2 Nature of Engagement for a Continuously Enlarged Crown Gear with a Pinion

Line Formation

All modern gear-cutting machines are based upon the molding process, by which, in theory, the teeth of the gear or pinion in process are molded or formed by the conjugating action of the teeth of a crown gear, or for spur gears, we may say, by the teeth of a rack. At present we will deal only with the development of the formation lines upon the pitch surfaces. This resolves itself into a study of these lines upon the pitch surface of the molding element, the transmitting of these lines to the pitch surfaces of the gear and pinion being entirely automatic. A defective line upon the pitch surface of the gear simply means defective crown-gear development.

[1] Consulting Engineer.
For presentation at the Annual Meeting, December 4 to 7, 1922, of The American Society of Mechanical Engineers. All papers are subject to revision.

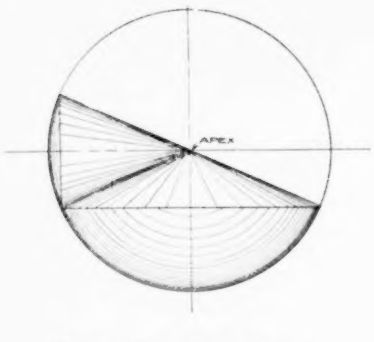


Fig. 3 True Pitch Cones

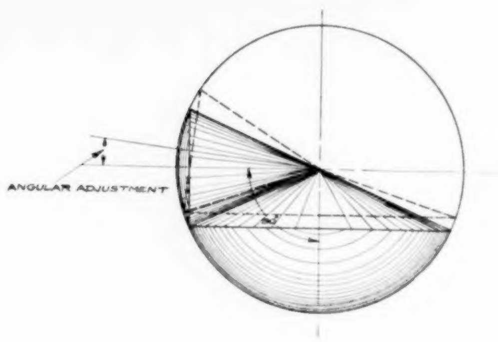


Fig. 4 Correct Separation of Pitch Cones

(Illustrating the increase in pitch cones due to an angular adjustment of axes. This corresponds to an increase in center distance for spur gears, and has a corresponding effect upon obliquity of action.)

Formation lines are developed upon the crown surface (pitch surface) of the crown gear. The outer circumference is spaced off to conform to the required pitch, and from each of these points upon the circumference we develop lines which approach the center or pole of the crown gear by means of an equiangular or logarithmic spiral of the desired angle. If a zero spiral, which will mold a straight-tooth gear, is required, we have only to draw radial lines from each point upon the circumference to the pole of the crown gear. Or if a spiral of, say, 30 deg. is required, the development line must be drawn so that any tangent forms a constant angle of 30 deg. with the radii vectores. That is, this line leaves a point upon the circumference of the crown gear at an angle of 30 deg. with a radial line drawn from that point, and continues obliquely toward the pole, forming a continuous line whose tangent with any radial line which may be drawn through it forms an angle of 30 deg., or any other desired angle of spiral. See Fig. 5. This same line being described from each point upon the circumference, the line formation of the crown gear is complete.

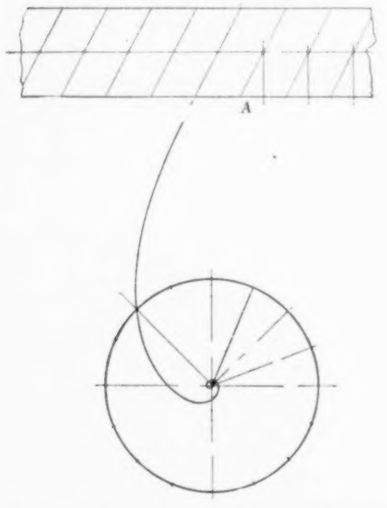


Fig. 5 Development of Formation Lines on Pitch Surface of the Crown Gear

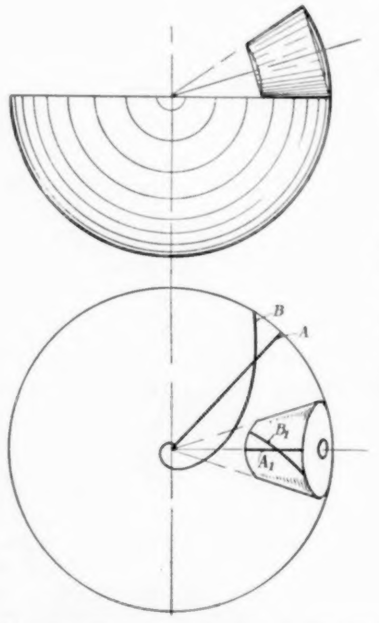


Fig. 6 Developed Lines on Crown Surface of Crown Gear

If we now consider the extension of the spherical radius to infinity we see that the pitch is laid off along a rack length, and this extension of the logarithmic spiral reaches the pitch surface of the rack as a straight oblique line at an angle from the vertical corresponding to the angle of spiral. See A, Fig. 5. In this extension, however, we refer to this angle as the "angle of helix." The spiral upon the conical pitch surface of the gear to be molded is the helix upon a cylindrical pitch surface. When the radius of the crown gear is infinite, radial lines become parallel lines, so that for straight teeth the developed lines upon the rack are simply drawn perpendicular to the lineal edge of the rack. Fig. 6 shows two developed lines on the crown surface. A is that of a zero spiral angle (straight tooth) and B a spiral development of about 35 deg. These lines are "printed" upon the pitch surface of the gear, as A_1 and B_1, by rolling the pitch surface of the gear over the pitch surface (crown surface) of the crown gear. The ratio of this rotation is as the sine of the pitch angle of the gear.

The Logarithmic Spiral

By reason of the growing interest in the logarithmic spiral and its application to spiral crown-surface development, also its interesting relation to the involute, it is thought that a treatment dealing with the spiral bevel gear should include a short description of the spiral. A graphical development is shown in Fig. 7. The radius vector is the distance from the pole to any point on the spiral. The radii vectores increase in geometric progression for a constant angle of advance. This angle (k) may be assumed and the ratio of progression P found as follows:

$$P = \frac{1}{2.7182818^{\frac{k \cot S}{57.293}}} \qquad [1]$$

in case the spiral development is negative, toward the pole, or from the radius vector r_1; and

$$P = 2.7182818^{\frac{k \cot S}{57.239}} \qquad [2]$$

in case the spiral development is positive, away from the pole, or, say, from radius vector r_{12}. S = angle of spiral.

We have $r_2 = r_1 P$

$r_3 = r_2 P$ or $r_1 P^2$

$r_4 = r_3 P$ or $r_1 P^3$, etc.

When the spiral is developed toward its pole the value (negative) of the ratio P will be less than 1, and for a development away from its pole (positive) the ratio P will be greater than 1. The constant 2.7182818 is the Napierian base. The radius vector is the side opposite. The instantaneous radius of the spiral at any radius vector is the hypotenuse of a right triangle, as shown in Fig. 7 by heavy lines. This same triangular relation continues at all points on the spiral. Assuming a spiral

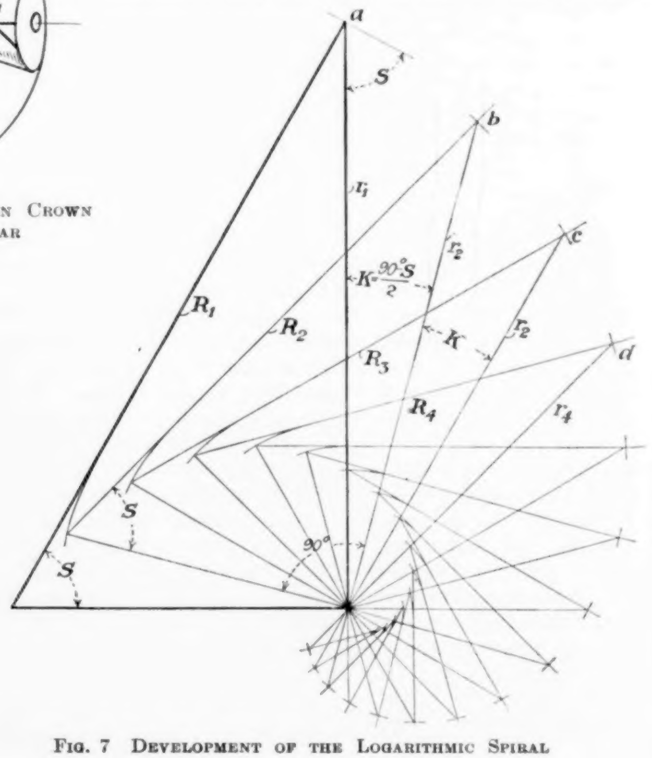


Fig. 7 Development of the Logarithmic Spiral

angle of 30 deg. and an angle k of 5 deg., the geometric ratio (P) for the spiral development by points, away from the pole, is found to be 1.163. Beginning with an initial radius vector, as r_{12}, of 1 in., the positive radii vectores increase in the following order:

r_{12} = 1.000 in.	r_8 = 1.830 in.	r_4 = 3.347 in.
r_{11} = 1.163 in.	r_7 = 2.128 in.	r_3 = 3.892 in.
r_{10} = 1.353 in.	r_6 = 2.474 in.	r_2 = 4.527 in.
r_9 = 1.574 in.	r_5 = 2.878 in.	r_1 = 5.265 in.

The geometric ratio for successive negative radii vectores toward the pole is $1/1.163 = 0.8598$; thus $r_2 = 0.8598 \times r_1$, or $0.8598 \times 5.265 = 4.527$; and $r_3 = 0.8598 \times r_2$, or $0.8598 \times 6.527 = 3.892$; etc.

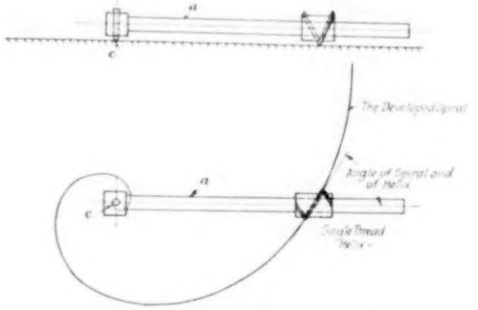


FIG. 8 DEVICE FOR DESCRIBING A LOGARITHMIC SPIRAL ON A CROWN SURFACE

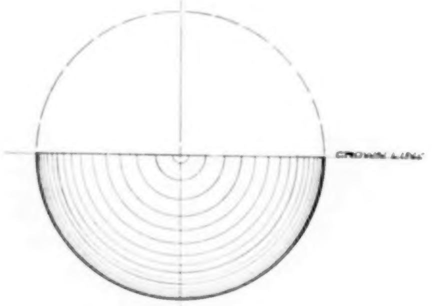


FIG. 9 CROWN-GEAR PITCH SURFACE

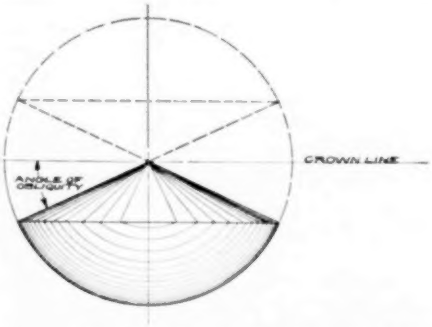


FIG. 10 BASE SURFACE OF THE INVOLUTE CROWN GEAR

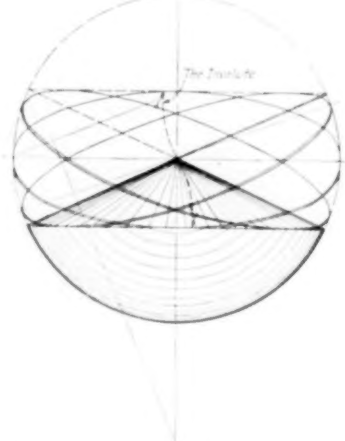


FIG. 11 DEVELOPING THE INVOLUTE FROM THE BASE SURFACE OF THE CROWN GEAR BY MEANS OF A DISK

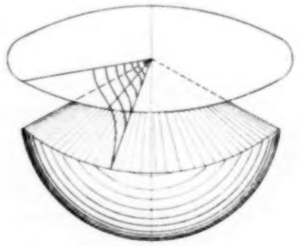


FIG. 12 INVOLUTE DESCRIBED BY SEVERAL POINTS ON DISK OF FIG. 11

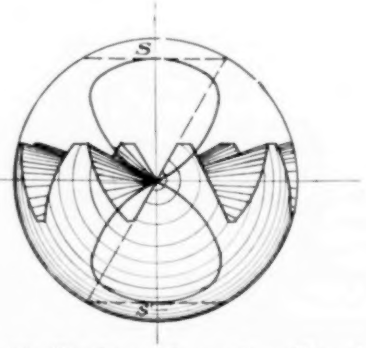


FIG. 13 THE OCTOID CROWN GEAR (GRANT)

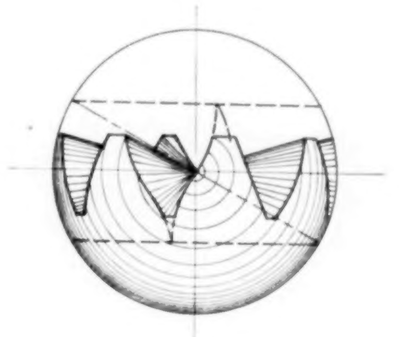


FIG. 14 THE INVOLUTE CROWN GEAR (GRANT)

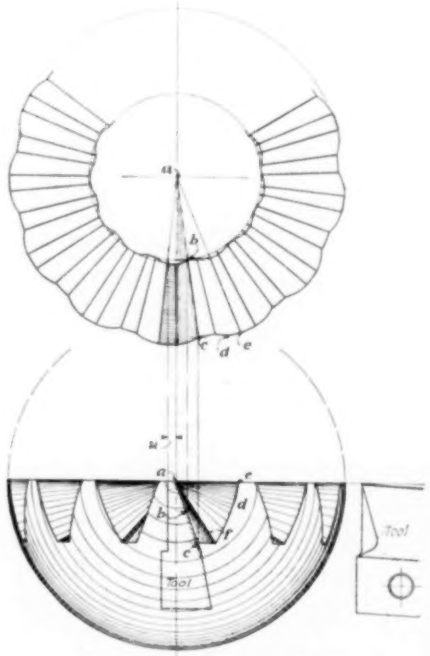


FIG. 15 GENERATOR TOOL REPLACING ONE SIDE OF THE MOLDING TOOTH

By making the angle $k = (90° - S)/2$, the spiral may be graphically developed by a series of points. Draw the first triangle to radius vector a as shown. Then draw potential radii vectores b, c, d, etc., at progressive angles k. Also draw base lines at right angles to these radii vectores. Now, with the pole as a center, strike an arc tangent to the hypotenuse R_1 of the first triangle, intersecting the base line of the radius vector b. From this intersection draw the second instantaneous radius (R_2) at an angle from the base line equaling the angle of spiral. This line will cut the potential radius vector r_2 at b, locating the second point on the spiral. Continue this development as far toward the pole as possible or as desired.

$$\text{Instantaneous radius of spiral } R \text{ (hyp. of triangle)} = \frac{r}{\sin S} \quad \ldots [3]$$

$$\text{Developed length of spiral} = \frac{r_1 - r_2}{\cos S},\ \frac{r_1 - r_3}{\cos S},\ \text{etc.} \ldots\ldots\ldots [4]$$

that is, the developed length of the spiral is found by dividing the difference in the length of any two radii vectores by the cosine of the angle of spiral, which is the same as the length of a helical development across the face of a rack, the difference in the length of the radii vectores being the length of the rack face.

A logarithmic spiral may be described upon a crown surface by means of a fixture such as that shown in Fig. 8. A single helical thread raised upon a cylinder whose angle with the axis is the desired angle of spiral, will describe this spiral when rolled around with the center of the crown surface as a pole. Less than one complete turn of the helix is required. The spiral may be extended as desired by sliding the cylinder along its axis a and continuing the development. This helix may be developed on the cylinder by means of the action of an oblique line upon the pitch surface of a rack. This oblique line is the result of an extreme extension of the spiral. (See last paragraph under Line Formation.)

INFINITY RADIUS

An infinity radius cannot be reached in practice, if it can be conceived at all. What is really meant by an infinity radius is a radius of such a length that no curvature can be detected within the length of the arc employed. This idea of an infinity radius will therefore vary with the means employed for describing the

length of the arc used and the skill of the draftsman. For a pair of 1 diametral pitch gears, the pinion radius being 6 in. and the ratio of reduction 25:1, we may ordinarily ignore the pitch radius of the gear in a graphical development of the tooth action and draw in the gear as a rack, as the pitch radius of the gear is 120 in. or 10 ft. Of course, a more careful or a more skilful draftsman might actually use a 10-ft. radius for developing the pitch circle of the gear within the action, but even the most careful or the most skilful man will finally reach a point where he will ignore the curvature and use a straight edge. Our measure of infinity is relative only, so that we may safely define rolling pitch surfaces within our conception as bounded by a sphere. This definition will be of material assistance in the study of the development of the teeth in the molding element, that is, in the crown gear, as it will show that the entire length of this crown tooth from its

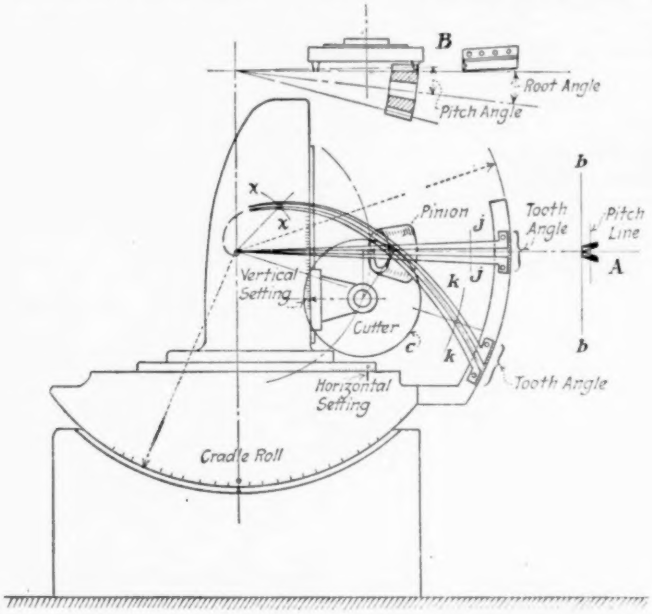


FIG. 16 THE GLEASON CRADLE-ROLL GENERATOR AS APPLIED TO THE PRODUCTION OF STRAIGHT-TOOTH AND SPIRAL BEVEL GEARS

pole or apex to our conception of "infinity" has but one development.

The Crown Gear

Fig. 9 shows the pitch surface of the crown gear. The base surface is developed by a cutting line from the pole that is inclined from the crown line to the desired angle of obliquity as shown in Fig. 10. The involute profile is developed by means of a flat disk whose radius is that of the sphere. A series of points upon this disk will describe the involute the entire distance from the pole to the outer radius of the sphere (see Fig. 11). This development at the outer point of the disk, it should be noted, is upon the *surface* of the sphere, and it must be continued at all points. This disk is operated exactly as though rolled around between two base cones, the upper base surface or cone in Fig. 11 being indicated by dotted lines. Fig. 12 shows the involute described by several points upon the disk and illustrates the surface development of the crown-gear teeth.

Referring again to Fig. 11, let us assume that this drawing was produced by photographing a similar layout in which the spherical radius was, say, 10 ft. The total height of the involute, as measured on Fig. 11, is but a small portion of the same height on the original drawing. This height upon the original drawing would show, for all practical purposes, a perfectly flat profile; therefore, as far as this particular height of development is concerned, the radius of this sphere (10 ft.) is infinity. No matter what extreme spherical radius we may consider, an involute developed thereon will be that of Fig. 11 in case the scale of our conception is reduced accordingly. It is apparent that the accuracy of the involute tooth is limited only by our conception of infinity. Even then we are always brought back to Fig. 11 if the full involute development is considered. Fortunately this is never required.

The Octoid Crown-Gear Tooth

It is obviously impossible to generate a bevel gear with the involute form of tooth. (See Fig. 11.) The involute-generating tool would present a peculiar double-curved profile difficult to form, as will be apparent; also it would be necessary for this profile to change as the tool approached the apex; therefore the involute "molding" crown tooth cannot be duplicated in practice. The "octoid" tooth owes its existence to the fact that its crown-gear tooth is the only practical generating or molding tool: the profile being flat, no change takes place or is required as it approaches the apex during its cutting action. We have taken our conception of an infinite radius development of the involute and have arbitrarily applied this conception to measurable radii, as ordinarily employed in bevel-gear practice. This means that the larger the bevel gears engaging at a given angle or the smaller the angle of axes for given diameters, the nearer the action of the teeth approaches that of the involute. Also it is apparent that as we approach the small ends of the teeth, a further departure from the involute is made in any one pair of gears. Thus we may say that the nature of the action of the teeth in any pair of bevel gears is constantly changed at each point along the face length. Figs. 13 and 14, from Grant's Treatise, show the involute and the octoid crown gear. It will be noted that the flat "octoid" crown-gear tooth results in an "hour-glass" or "figure-eight" line of action, from which this form of tooth derives its name.

Generating the Teeth

In practice the teeth of the molding crown gear are replaced by cutting tools, which are of course necessary for non-plastic materials. Fig. 15 shows the planing tool which replaces one side of a tooth in the conventional crown gear. The length of face that may be cut is limited by the width of the point of this tool, or by *u*. Point *a* on this planing tool must be so located that its cutting plane represents both the side of a crown-gear tooth and the line of the bottom of the tooth space. To generate the opposite tooth space, a similar tool must be placed to represent the opposite side of the same crown-gear tooth. The point of this second tool must be located at *e*, its cutting edge representing the side *d* and the bottom or root line *f* of the crown-gear tooth. Both point *a* and point *e* must travel toward the apex *a'*.

Fig. 16 shows an outline of the Gleason cradle-roll generator as applied to the production of both straight-tooth and spiral bevel gears. The "molding teeth" for both types are here represented by tapered triangular wedges as shown at *A*, the angles of the sides of these wedges being formed to the angle of obliquity. The apex of these "wedges" is the apex or pole of the crown gear. Each pair of wedges are adjustable for tooth size by means of "tooth angle" settings, and their tops lie in a plane parallel with the cradle roll or on the crown line. In action the cradle rolls around the apex of the "crown gear" and the pinion or gear in operation rotates upon its axis, the action between the two being that of the pitch surface of a bevel pinion with the pitch surface of a crown gear as illustrated by Fig. 2. It will be noted that, as in Fig. 15, the tops instead of the pitch line of the crown-gear teeth are upon the crown surface and intersect the pole parallel with the cradle roll. This modification does not in practice seem to affect the accuracy of the gears, although the tops of the teeth in the molding gear (points of tools) should intersect the pole at an angle with the crown surface equal to the dedendum angle of the gear in process. The Bilgram generator does not contain this error, however. Any acting section of these molding teeth is taken with the pole as a center, as sections *j-j* and *k-k*. Proportional thickness is as the radial distance, as *x-x* to *k-k*, etc.

In practice the *straight* molding wedges are replaced by planing tools as shown at *B*, Fig. 16, and an approximation of the spiral wedge is secured by mounting a circular cutter, as *c*, so that its radius approximates the instantaneous radius of the spiral at the average apex distance of the gear in operation, as is shown. This cutter is rolled around the apex of the generator exactly as the spiral wedge and may be made, by various vertical adjustments, to represent a tooth in the molding crown gear; this, however, cannot be a true spiral but is an approximation thereto by means of a circular arc of a fixed radius. As shown in Fig. 16, vertical and horizontal settings are employed to locate properly the cutter

at its best average position, and these settings are also employed to allow the circular cutter to represent each side of a crown-gear tooth. Since the tops of the teeth in this cutter are set to the crown line, the axis of the gear in operation is set to its root instead of its pitch angle. The ratio of roll, however, is based upon pitch-surface contact. This pitch-surface contact does not actually occur unless we consider the pitch angle of the crown gears as being less than 90 deg. (see Fig. 17). The practical error, however, is slight.

Fig. 17 shows the engagement of two crown gears as embodied in the action of the machine in question. For spiral bevel gears a pair of such crown gears are necessary, as a right-hand spiral crown gear is required to mold a left-hand spiral pinion and a left-hand crown gear to mold a right-hand spiral gear. A study of the entire matter is therefore reduced to a study of these two crown gears. If they will not properly engage, we cannot expect a satisfactory product. The generator is the crown gear; that is, the action of the generating tools must be studied as if they were the teeth of the crown gear which, in theory, "molds" the teeth in the production gears.

Contact Lines

The important point to bear in mind when designing or when generating any "twisted tooth" gear, either spiral bevel or helical spur, is that their action and formation is exactly that of straight-tooth bevel or spur gears at any instantaneous section. The essential difference between twisted and straight-tooth gears is that in the former the instantaneous line of action across the face of the tooth is diagonal—at an angle with the pitch surface approximating the angle of the spiral or helix, while in the latter the action is along radial lines for bevel gears and along parallel lines for spur gears. Thus with straight-tooth gears the contact occurs instantaneously across the entire length of face, while for twisted-tooth gears it is distributed over different points of the line of action and across to adjoining teeth.

In case the axial distance between any two adjoining teeth (axial pitch) is less than the face width, we have, theoretically, a "pitch-point lock;" there being continuous contact at the "pitch point" or at the intersection of the line of action with line of centers, which is also the common point of tangency of the two pitch circles. This pitch-point lock should assure uniform velocities, but this is defeated mainly through errors in spacing. A pitch-point lock, as specified, is not essential to the quiet operation of any pair of gears: there is no sharp dividing line between successful and unsuccessful gears upon this basis. Any angle of spiral or of helix will help, and this assistance increases with the angle through a fairly uniform field. In turbo-reduction gears the axial pitch is often as low as one-twentieth of the face width, and the number of teeth in instantaneous contact across the pitch point is very often in excess of the number of teeth in the pinion. For such a condition we may say that an actual pitch-point lock is "approached," at least, but it is never attained in practice.

The total length of contact in twisted-tooth gears is exactly the same as for straight-tooth gears when based upon the number of teeth in contact upon the acting (virtual) section and the length of face: the number of contacts points times the length of bearing at each point is always equal to the number of teeth in contact upon the acting section times the length of the face.

Conventional Practice

In practice we often lose sight of the spherical nature of bevel gears. Fig. 18 shows the conventional development of the bevel gear by dotted lines. The back angles are machined flat and the back face or seat must of course be flat, but the spherical principle may be adhered to by adding any desired amounts, as b or b_1, to the "back cone distances" a and a_1, obtaining distances c and c_1 and employing these dimensions as a basis for all cutting and inspection operations. Both the generator and the testing machine must be set up in strict accordance with these dimensions. See Figs. 19 and 20.

It is apparent from a study of Fig. 18, also by reference to Figs. 3 and 4, that when bevel gears are designed to operate at any particular shaft angle (usually 90 deg.), operating clearance (backlash) must be cut in the teeth. In case the teeth are cut full size—that is, if the combined circular thickness of gear and pinion teeth is made equal to the circular pitch—the angle of axes must be increased in order to secure operating clearance, which is absolutely essential to the successful operation. It will be noted that operating clearance is an angular measurement; therefore, when gears are designed to operate at a shaft angle of 90 deg., the amount of backlash secured may be measured by operating these same gears without backlash and noting the angle of engagement, which must then be less than 90 degs. (see Figs. 21 and 22). Fig. 21 shows the gears held as they are to operate, with operating clearance between the teeth. Fig. 22 shows the effect of eliminating this clearance by dropping the pinion into snug engagement with the gear. In this figure the pinion has been dropped around the apex or shaft intersection, which is the center of the sphere. It will be noted that the back face of the pinion now leans away from the gear at an angle which is the same as the change in angle of axes. An oversize pinion would lean in, increasing the angle of axes. This angle might be termed "pinion inclination." A pair of pointers (Fig. 23) will show that for straight-tooth bevels the radial lines of the teeth intersect the crown line at some one point, and a measurement by pinion inclination will at once show whether or not this point of intersection is the apex or pole of the crown gear.

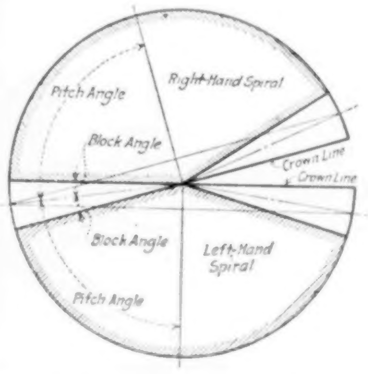


Fig. 17 Engagement of the Molding Crown Gears

When a pair of spur gears are moved into engagement, the tops of the teeth are first brought parallel with each other, and as the centers are farther reduced the engagement will occur at the extreme face of the tooth profiles and across their entire length. The backlash is gradually reduced as the gears are moved toward each other, with a continued deepening of their engagement until the desired amount of backlash is secured. This is their correct operating position and if the resulting distance between centers is not as required, the thickness and perhaps the depth of the teeth must be corrected accordingly. To parallel this procedure in the assembly of bevel gears, they must be rolled around each other with the intersection of their axes (center of sphere) as a center. Thus, to bring the faces parallel as the gears enter contact, the angle of axes must be increased an amount equaling the sum of their addenda angles, as shown in Fig. 24. Fig. 25 illustrates the result of an attempt at axial adjustment which is ordinarily thought to amount to the same thing as a parallel movement for spur gears. The axial position of bevel gears must be assumed as fixed: we are given no leeway in this respect except, of course, to determine the possibilities of assembly range when the gears are mounted in service.

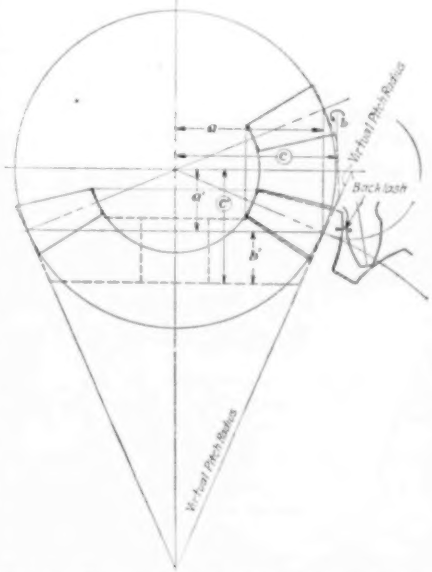


Fig. 18 Theoretical Construction of Bevel Gear, with Conventional Layout Shown in Dotted Lines

Effect of the Spherical Radius upon the Design and Assembly of Gears

Referring again to Fig. 1, it will be noted that as the radius of the sphere enclosing the pitch surfaces is increased, the change in the pitch across the length of the gear face is reduced; that is, the change in the pitch within the face length is more rapid with the smaller radii. When the radius of the sphere is infinite, there is no change in the pitch engagement; that is, the pitch is the same across the entire length of face. It follows that when a large sphere encloses the pitch surfaces, the change in the pitch relation is

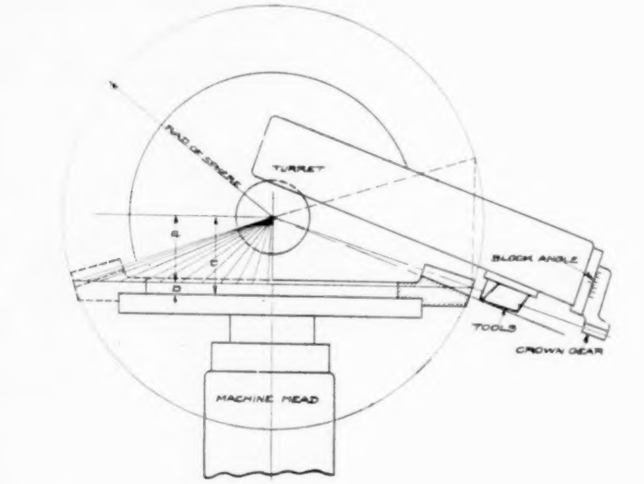


Fig. 19 Back Cone Distance on Gear-Tooth Generator

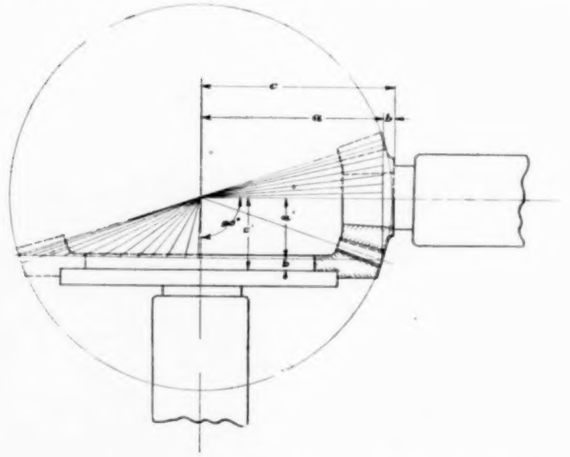


Fig. 20 Fixed Position of Testing-Machine Heads

correspondingly slight. Thus, spur gears can be assembled as desired; any "error" in their axial location cannot affect their operating quality; also the pitch diameters and the obliquity of action adjust themselves to whatever center distance may be employed.

Changes in the center distance of spur gears correspond to an angular change in the axes of bevel gears, so that an angular error in the shafts upon which bevel gears are mounted simply changes the amount of operating clearance, and aside from this cannot be called an error. Bevel gears are therefore essentially different from spur gears in that a correct axial location must be secured for the former, while it is of no importance in the assembly of the latter type. Spur gears need only be correctly cut and assembled on parallel shafts. Bevel gears must be so designed and cut that a *range* of axial adjustment (which does not affect spur gears) is allowable in their assembly. In fact, this allowable range of adjustment is taken as a measure of operating quality. It is impossible always to assemble bevel gears with their pitch cones intersecting exactly, or to maintain such an exact condition in service; therefore in the design of the teeth we must provide for the engagement of unequal pitches. A pair of bevel gears which will operate as desired in but one exact position, as specified, have little or no commercial value, while an equally accurate pair of spur gears would fulfill all requirements.

Tooth Design

Gear and pinion addenda, also proportional tooth thickness, as recommended by the Bilgram Machine Works represent excellent practice for 14½-deg. or 15-deg. straight-tooth bevel gears. We might well apply the same principle to 20-deg. gears or, for that matter, to those of any obliquity desired. For 20-deg. gears, however, the addenda may be made equal for both gear and pinion with good results, the addendum in each case being 1/pitch. The design of spiral bevel-gear teeth is too unsettled at this writing for any recommendation to be made and cannot well be included within the scope of this paper. Attention, however, should be called to the connection between spiral bevel and helical spur gears. In addition to this we also have the herringbone-gear practice to draw upon for points in the design of the spiral bevel gear.

A proper determination of the number of teeth in the gear and pinion is of first importance. The basis for this is the pitch diameters, obliquity, and angle of spiral. The working depth is properly a function of the pitch so that suitable profiles may be obtained, and this working depth is properly proportioned between the gear and pinion addenda on a basis of the ratio of reduction and the angle of obliquity. The difference between the gear and

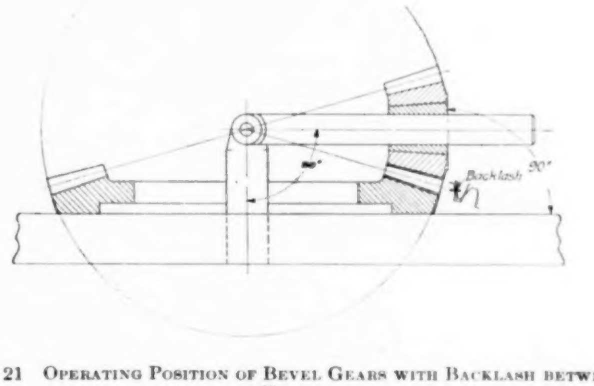


Fig. 21 Operating Position of Bevel Gears with Backlash between Teeth

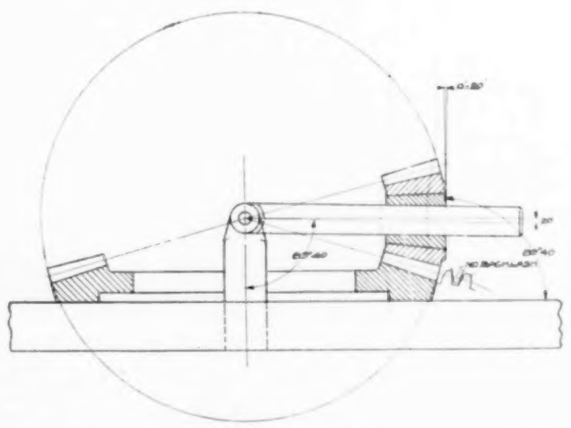


Fig. 22 Pinion Inclination to Eliminate Backlash Shown in Fig. 21

pinion addenda is the greatest for the lowest obliquity used (say, at 14½ deg.), and as the obliquity is raised the difference between the gear and pinion addenda is less pronounced. Thus the employment of equal addenda for 14½ deg. is prohibitive for the ratios, while for an obliquity of 22½ deg. it is good practice and may ordinarily be recommended for an obliquity of 20 deg. in case the pinion tooth is not too weak.

The usual bevel-gear reduction for automobile drives is around

5:1, varying from 3:1 to 6:1. In spur gears this would correspond to ratios between 9:1 and 36:1, the usual ratio being 25:1. For such ratios the angle of approach may be made equal to the angle of obliquity; that is, the slide at the beginning of the arc of approach may be 100 per cent without excessive wear. For obliquities of $22\frac{1}{2}$ deg. or less, no sign of excessive wear has been found upon the approach with an angle of approach which equaled the obliquity; that is, with bevel-gear ratios in excess of $3\frac{1}{2}$:1. On the other hand, it is recommended that the angle of recess be limited to $22\frac{1}{2}$ deg. for all obliquities. Practically the same percentage of roll is found for each ratio, independent of the angle of obliquity, so that it is possible to reduce the number of teeth as the angle of obliquity is increased with no change in the relation of slide to rolling action. It might be suggested here that the allowable percentage of sliding contact on approach and on the recess be proportioned on a basis of the ratio of reduction, as it is apparent that no fixed rate can properly cover all ratios, or that the amount allowed on approaching action must be restricted to that which properly limits the amount of slide on the recess, at least for the usual automobile bevel-gear reduction.

It is thought that the mean percentage of sliding contact is a poor gage by which to measure wearing quality. The point to be watched is the maximum instantaneous percentage of slide. It has been noted that an angle of recess just a little to great has caused failure; also, when the maximum instantaneous points are within proper limits, that little or no improvement in wearing

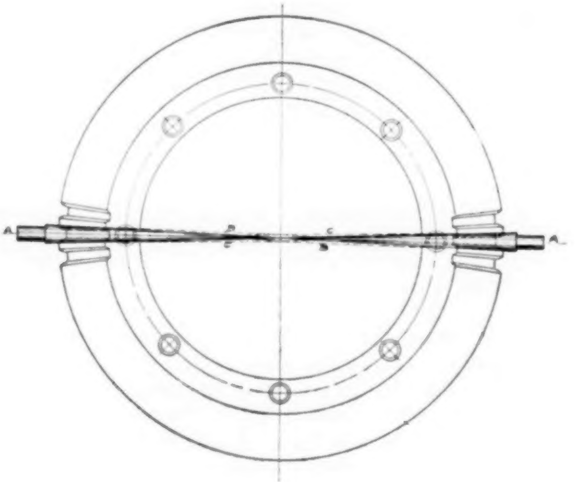


Fig. 23 Proper Use of Pointers

[*A*, Tools properly set toward apex; *B*, Tools improperly set (Drop both tools if bearing is crossed); *C*, Tools improperly set (Raise both tools if bearing is crossed).]

quality is found by a further reduction. With the maximum instantaneous points of contact within proper limits, it is thought that comparative wearing quality is properly gaged by the sine of the angle of obliquity, taking the torque from the base radius and as the sine of twice the angle of obliquity for given pitch diameters; the sine times the cosine being the sine of twice the angle, divided by 2. Thus, $14\frac{1}{2}$-deg. gears may be compared with 20-deg. gears as the sine of 29 deg. to the sine of 40 deg.; that is, 0.6428/0.4848 = 1.33, or 33 per cent in favor of the 20-deg. gears, the pitch diameters being the same for each obliquity.

Mean Tooth Pressure

In designing the housings for bevel gears it is important that correct thrust loads be determined, especially when we are dealing with the spiral bevel gear. It is not the intention here to enter into these axial-thrust calculations, but simply to point out means by which the mean tooth pressure, as affecting the thrust loads, may be obtained. Ordinarily we are given a distance on the pitch surface of the bevel pinion one-third the face length from the large end of the tooth as the point from which this pressure may be calculated, but this is thought to be in error.

Suppose, for example, that the *average* pitch radius of the pinion is 1 in. and the pitch angle is such that the pitch radius at the small end of the pinion is 0.5 in. and at the large end is 1.5 in. The motor torque is, say, 4000 in-lb., therefore the pressure as figured at the small end of the tooth of the bevel pinion would be 8000 lb.; but the pressure at the large end of the tooth would be 2667 lb., not 2000 lb., as might be our first estimate. This pressure (2000 lb.) is attained at a pitch radius of 2 in. From this it is evident that the point of mean pressure must be located somewhat toward the small end rather than toward the large end of the tooth.

Pressure on the teeth varies, of course, inversely as the pitch radii, but the pitch radii do not change with the proportionate distance from the average along the pitch surface. Plotted values for pitch radii and proportional tooth pressure will develop a hyperbolic curve, not a straight line. We have:

$$M = \frac{c}{d - e} \log_e \frac{d}{e} \quad \ldots\ldots\ldots\ldots\ldots\ldots [5]$$

in which M = mean tooth pressure
c = motor torque in inch-pounds
d = maximum pitch radius
e = minimum pitch radius
r = mean pitch radius.

To locate the mean pitch radius, we have:

$$r = \frac{c}{M} \quad \ldots\ldots [6]$$

As an example, let c = 1000 lb., d = 1.5, and e = 0.5. Then d/e = 1.5/0.5 = 3.0, for which $\log_e$ = 1.0986. Whence—

$$M = \frac{1000}{1.5 - 0.5} \times 1.0986 = 1000 \times 1.0986 = 1098.6 \text{ lb.}$$

and—

$$r = \frac{c}{M} = \frac{1000}{1098.6} = 0.9102 \text{ in.}$$

The average radius is 1 in. Ordinarily it would appear sufficiently accurate to consider the *average* as the mean pitch radius and figure thrust loads accordingly.

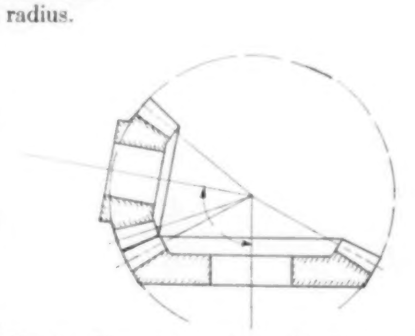


Fig. 24 Bringing the Faces Parallel as the Gears Enter Contact

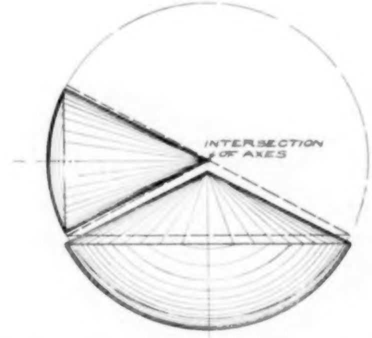


Fig. 25 Effect of Axial Adjustment of the Pitch Cones of a Pair of Bevel Gears

(Dotted lines illustrate automatic rearrangement of pitch cones in case gear is moved away from pinion along its axis in an attempt to increase the backlash; that is, to obtain operating clearance not allowed in cutting the teeth. The real apex point is the intersection of the gear and pinion axes. The figure shows the lines of action crossed due to the movement of the gear outside the sphere.)

A Discrepancy in Calculated Tooth Thickness

Allowing for the chordal thickness of a bevel-gear tooth upon the virtual pitch radius along which the back face of the teeth are machined, also allowing for the chord of the sphere enclosing the pitch surfaces proper, there is still a discrepancy between the calculated and the required thickness of the teeth. A pair of bevel gears will not assemble as in their fixed operating position (see Figs. 19 and 20) until the teeth are cut somewhat smaller than the figures given. Undoubtedly the calculations are in error: the profile of the teeth upon the sphere is evidently not properly understood, as the discrepancy varies with the radius of the sphere. For a radius of 3 in. (5 pitch) it is necessary to reduce the size of either gear or pinion approximately 0.015 in., while for a spherical radius of 5.5 in. the usual amount necessary is 0.010 in. This is offered as an interesting point which has up to the present time defied solution, although the explanation is probably simple enough, as are all fundamentals of gear design.

Suggestions as to Standardization of Machine Tools

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THERE are two outstanding phases of the problem of standardization of machine tools, one as it affects the builder and the other its effect on the user of the machines. The former can be left to the builders themselves, as it affects the cost of manufacture and the amount of capital invested. The latter, the effect of standardization on the user, is of direct interest to all.

One of the first considerations in making or advocating any change from existing practice is whether the benefits to be derived are worth the cost. This holds good with the proposals for standardization of machine tools, and this question of cost very frequently makes what we are pleased to call standardization really a matter of elimination. We usually eliminate unnecessary sizes and make those which we retain the standard, rather than adopt an entirely new standard which is the result of careful investigation, calculation, and experiment. And while this may not be the ideal procedure, it is the practical solution in most cases. Devising a new standard too often means simply adding another variety rather than eliminating many which are now in use.

The Advantage of Uniformity

Those who deprecate this unscientific method of standardization should remember that one of the greatest advantages of standardization, perhaps the greatest, lies in uniformity rather than in perfection as to the standard adopted. Taking the gear shift of an automobile as an example, the question of superiority in any particular shift sinks into insignificance in comparison with the advantages of having any one of the gear shifts adopted as standard on all cars. The typewriter keyboard is another excellent example of this.

Standardization of machine tools from the standpoint of the user can be confined to two specific points, work-holding and tool-holding devices. The former affect principally the spindle noses of lathes and the T-slots of planers, milling machines, boring machines, drilling machines, and the like. Tool-holding devices affect the spindle noses of milling machines and drilling machines, turret holes, tool posts, grinding-wheel spindles, etc. And while these look innocent enough on the surface, it does not take long to find that it involves the old controversy as to tapers, which is enough to start a heated argument in any shop.

Interchangeability and Accuracy

Every mechanic who has handled precision work knows that it is not practicable to interchange lathe chucks on very accurate work with the idea that the chuck will run dead true on more than one machine. On the great majority of work, however, the ability to change chucks from one lathe to another, without the bother of making adapters (which usually add considerably to the overhang) would be of great service in many shops. In the same way fixtures should be interchangeable from one machine to another by the use of standard T-slots in the tables and probably a standard distance of the first slot from the edge of the table.

The inability to use given turret tools in more than one machine imposes an unnecessary expense on the shop overhead and also directly affects future sales of the machines in question. The builder whose machine has odd sizes of turret holes, for example, will have a hard time securing an order from a shop equipped with machines having a different size, even though one be as logical as the other. And while an order once secured might tend to force a continued use of this machine, it is apt to prevent an order at least as often as to secure one.

T-Slots

The standardization of T-slots is probably the easiest place to make a beginning, and here again it will undoubtedly result in the elimination of perhaps half the sizes, retaining only those which are necessary. A canvass of the total number of each size of T-slot cutters sold should make it easy to select the sizes most in use.

But even T-slots have several points to be considered: the width of slot opening, the width and depth of the T for the bolt head, and the depth of metal over the slot to resist pulling out a piece of the table. Uniformity as to this latter feature is, however, less important than the width, as that is what affects the use of tongs for locating milling fixtures and the like. The distance of the outside T-slots from the edge of table is also important.

It may be well to emphasize right here that no matter what is being standardized, it must be remembered that a definite tolerance must be given in each case. And in considering tolerances, let us bear in mind that the modern tendency is toward a unilateral tolerance—a plus tolerance on the slot or hole and a minus tolerance on the part which fits into it. Let us get away from the "plus *or* minus" tolerance on the same piece.

Standardizing T-slots also involves the standardizing of the T-bolts which are to be used in them. Carl Barth has given this careful attention and his recommendations have been taken up by H. Cadwallader, Jr., of Philadelphia, who now manufactures T-bolts to the Barth standards.

Another point to be considered in standardizing work and tool-holding devices is to have the same size on as many machines as may be practicable. It may often be convenient to use the same chuck on a 14-in. and a 24-in. lathe. This is probably too big a range to be adequately covered by the same spindle nose, but it is quite possible that the same size of nose might be used on two or three sizes of machines. Some builders already use the same feed box on different sizes of machines, which is a very sane and sensible practice.

There is considerable talk of standardizing machine capacities, such as the swing of a lathe. But while it would be more convenient all around to know just what was meant by a 14-in. lathe, this is really a problem of the salesman and the buyer. If the seller prefers to cut prices by selling a 17-in. lathe under the name of a 14-in. lathe, it hardly affects the user so long as the work-holding or tool-holding devices on the lathe are standardized.

The milling-machine builders have perhaps done more in this line than builders of any other machine tools. A No. 1 machine now has approximately the same capacity in nearly all makes. The use of numbers, however, has little to commend it, whether it be milling machines or wire gages, and it is believed that main dimensions as to capacity would be more satisfactory to users.

Standardization Does Not Hamper Progress

One of the stock objections to standardization is that it prevents progress and the development of new ideas and designs. If, however, we consider that the Society of Automotive Engineers has done more in the way of standardization than any one else and then note the development in the automobile industry, this objection is easily answered. Is it likely that automobiles or other machinery would be more highly developed if each builder used a special-sized nut with a special thread? Standardization of such parts as nuts, piston pins, and other parts simply means that the designer calculates his requirements, such as to the kind of loads and stresses, and selects the standard part which meets his needs instead of designing an entirely new nut or pin of a slightly different size. It must also be remembered that standards are not as fixed as the pyramids, but can be changed whenever occasion really demands.

While all our efforts at standardization at this time should be devoted to such details of machine tools as affect the user, such as work- and tool-holding devices as has been pointed out, it is quite probable that the machine-tool builders themselves may find further standardization desirable. Research may show that bearings of certain dimensions are best for given spindle loads and speeds. Designers would then determine the load to which the spindle of a new machine would be subjected, and after considering all the conditions, would select the proper bearing from a list of standards.

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Presented at the Springfield Regional Meeting of The American Society of Mechanical Engineers, Springfield, Mass., September 25–27, 1922.

This would simplify manufacture and greatly reduce the number of tools and gages to be carried in stock, as well as the stock of bearings themselves. This phase of the matter, however, does not concern the user of the machine, and he will do well to confine his efforts at securing standardization to such features as concern him directly.

The Problem of Securing the Adoption of Standards

In addition to the engineering and economic aspects of machine-tool standardization, there is the adoption phase—for all practical purposes this is a selling problem. The best engineers of the United States, or of the world for that matter, may gather in solemn conference and decide that certain standards shall be established, but they have no power to do anything more. If the manufacturer concludes that his present practice is sufficiently satisfactory and is not convinced of the need for innovation, there is little that the standardizers can do.

Very often the problem is essentially a "selling" problem and one for which the average engineer is temperamentally unsuited. Diplomacy, tact, persuasiveness—the stock in trade of the salesman—are needed at this stage of the game. Even they would be futile if no means were at hand for gathering together the men who must make sacrifices if a standard is to be adopted, for lacking such means the task of reaching each man individually and reconciling his views with those of all the others, would be herculean.

The machinery for handling the engineering and industrial problems connected with this phase of standardization already exists in the American Engineering Standards Committee, and the rules of procedure of this committee are designed to bring about the early adoption of approved American Standards. To this end all Sectional Committees are required to include in their personnel representatives of *all* organizations which are in any way interested in the manufacture or use of the standard under consideration. Since these organizations are officially represented on the committee which prepares the standard, it is obvious that the members of these organizations are committed to the adoption of the standard to the extent that any individual or firm is committed by the actions of an organization to which he or it belongs. Just how well this arrangement is going to work out when it comes to universal adoption of a standard it is too soon to say, but at least the plan shows promise.

It may be that the Division of Simplified Practice of the Department of Commerce recently organized by Secretary Hoover will have a part to play in securing the general adoption of the standards for small tools and machine-tool elements which are to be developed by the Sectional Committee sponsored jointly by the National Machine Tool Builders' Association and The American Society of Mechanical Engineers. This, of course, will be determined as the work of the Committee progresses.

So far the Division has done its best work in fields of industry not closely connected with engineering. It is coöperating, however, to the fullest extent with the American Engineering Standards Committee in furthering the establishment and introduction of standards.

Standardization is a tremendous job and it may prove to be one beyond the capacity of any standards body yet organized. But it is a job that must be done and some means will have to be found. For the present, existing agencies should be given the fullest possible support by every one interested, manufacturer or user. Whatever is accomplished will benefit every one and is well worth any sacrifices that may have to be made.

Standardization of Small Tools

How the First Cost of Small Tools Can Be Greatly Lowered, without Sacrificing Their Efficiency, by the Adoption of Standards That Will Permit Their Manufacture on a Quantity Basis

By CARL J. OXFORD,[1] DETROIT, MICH.

Machine tools and small tools are so closely related to each other and interdependent that their respective developments logically should go hand in hand. In the past we have had instances of close coöperation between machine-tool builders and small-tool manufacturers. The results have invariably been noteworthy, and beneficial both to the coöperating firms, and to the tool-using industries in general.

Powerful and rapidly operating machine tools may be designed and built, but their success is largely nullified if they require cutting tools of prohibitive cost and of short life. Conversely, small tools may be developed which with the proper machine tools will produce wonderful results, but which again with unsuitable machines are complete failures.

We have been, and are still, passing through a period in our industrial development where reduction of expenses has become the watchword. Particularly is this true of those expenses which may be classified as production costs. Facing, as we now do, keenly competitive markets, it becomes necessary to cut the cost of production to the core, if the manufacturer is to show a balance on the right side of the ledger.

There seems to be but a scant likelihood that either raw-material or labor costs will recede to a lower level in the near future. In fact, we have recently seen slight increases in both. The lowering of production costs must therefore be accomplished through improvement in methods, and through increased productivity and efficiency of tools and equipment as compared with first costs.

It is the primary purpose of this paper to point out how greatly the first cost of small tools can be lowered, without sacrificing their efficiency, by the adoption of standards that will permit manufacturers of tools to produce on a quantity basis.

Classification of Small Tools

Twist drills, reamers, and milling cutters all are classed as small tools. In this paper only these three types will be considered. Usually the manufacturer classifies them as being either standard or special.

Standard tools are those sizes and designs which are regularly catalogued and carried in stock by the larger manufacturers, while special tools are those made up to the customers' specifications.

There exists at present a fair uniformity of general dimensions in the tools catalogued as standard by the various makers. This is a step in the right direction; but the belief is expressed here that this uniformity could be carried more into detail, and that the number of standard items listed could be cut almost in two without any serious handicap to the metal-working industries in general.

It is difficult to realize, by those not actively engaged in the small-tool business, what a wide variety of styles and sizes are catalogued as standard tools. An examination of several tool-manufacturers' catalogs shows the following average number of items:

Twist drills	3400 items
Reamers	2200 items
Milling cutters	4500 items

Roughly this makes a total of 10,000 items. Certainly this ought to be enough of a variety to take care of every conceivable requirement. That such is not the case, however, is illustrated by the fact that small-tool manufacturers are annually making thousands of items of tools not listed in their catalogs, and must continue to do so as long as their customers insist on having them.

Standard vs. Special Tools

It is conceded that there are numerous instances where special

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Presented at the Springfield Regional Meeting of The American Society of Mechanical Engineers, Springfield, Mass., September 25-27, 1922.

tools are necessary; but the statement is made advisedly that in many shops from 40 to 60 per cent of the work now performed with special tools could be equally well performed with standard tools, *and at a much lower tool cost*. To accomplish this it would be necessary, however, to educate the designers of both the manufactured article itself, and of the various holding and locating fixtures, to the importance of adapting their designs to the most economical uses of tools.

Instances are numerous where no end of troubles are encountered in machining because the designers have paid more attention to the purely technical side of design than to the practicability of performing the various machine operations specified.

In the production of many manufactured articles the cost of perishable cutting tools, such as drills, reamers, and milling cutters, represents a large percentage of the total productive cost. As a consequence the question of efficient and long-lived tools has come in for considerable attention. The present tendency, however, seems to be toward the use of special tools where an increased production is desired, or where trouble is encountered.

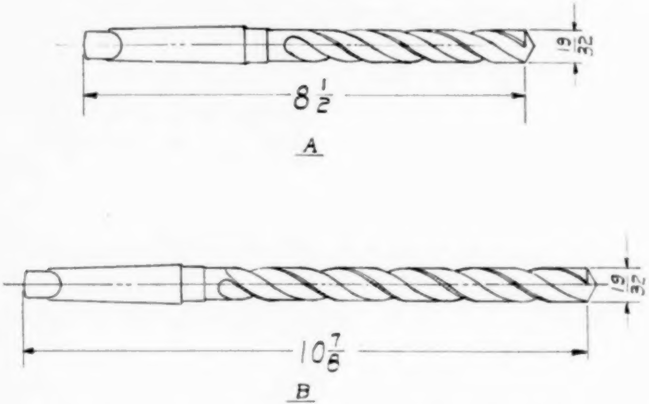


Fig. 1 Comparison of Standard-Length and Extra Long Taper-Shank Twist Drills

This is believed to be a fallacy in great many cases. For if a little time and effort is expended in adapting the conditions, such as surface speeds, chip thickness, and holding devices, it is often found that equally good or better results can be produced with standard tools than with special tools, although the latter must be obtained at a much higher price.

In addition to the higher price of special tools, it must be borne in mind that these are only made up in quantities as specified by the user. Hence the source of supply is restricted, and deliveries are subject to delays. Standard tools, on the other hand, can be purchased on the open market and can usually be delivered from the manufacturers' stock.

Relative Costs

Standard tools which are carried in stock by both manufacturers and dealers can naturally be made up in fairly large quantities. Usually from about five hundred to ten or twenty thousand of each size and kind can be put through the factory at one time. This means that many of the benefits accruing from quantity production are realized.

There is little time lost in setting up the machines, operators become more efficient on repetition operations, and in many instances it is possible to utilize multiple equipment and other time-saving devices.

The non-productive overhead incidental to every order is also spread over a great number of pieces, so that the amount chargeable against each piece is very small. All these conditions combined result in a low unit cost.

Compare this with the cost of producing special tools. These are as a rule ordered in small quantities ranging from one to ten or twenty pieces. Highly skilled all-around machine operators must be employed for this class of work. There is just as much time lost in setting up each of the various machines for one piece as for one thousand or ten thousand. There is no opportunity of using multiple equipment on such small numbers of pieces, nor do the machine operators acquire any increased efficiency from repetitions.

Non-productive overhead expenses are nearly as high for one or two pieces as for several thousand. The difference is that in one case these expenses must be absorbed by one or two pieces, while in the other case they can be distributed over a very great number. It is obvious how this will affect the respective unit costs, and eventually the price at which the tools must be sold.

Concrete examples of comparative costs will perhaps illustrate the point more forcibly. Let us compare the two twist drills *A* and *B*, Fig. 1. Both are $^{19}/_{32}$ in. in diameter and of identically the same design throughout except that drill *A* is of standard length or $8^1/_2$ in., while drill *B* is $2^3/_8$ in. longer, or $10^7/_8$ in. Five hundred of the drills *A* were made at one time, this being a standard size. The drills *B*, being special, could be made only in quantity as specified by the customer, in this case six.

The direct labor cost of *A* proved to be only 38 per cent of the corresponding cost of *B*. Adding the non-productive overhead, chargeable against the respective orders of which these drills were a part, the total cost of the standard drill *A* was found to be but 21 per cent of that of the special drill *B*.

Representing this in another way, we may say that the increase in length of *B* over *A* was 28 per cent, while the increase in cost was 480 per cent.

Similarly, we may compare the two milling cutters *C* and *D*, Fig. 2. The special cutter *C* is slightly smaller than the standard cutter *D*, yet, owing to the quantities manufactured in each case, the total cost of the cutter *C* was found to be 270 per cent higher than the corresponding cost of *D*.

These are but ordinary illustrations of conditions as encountered by every tool manufacturer.

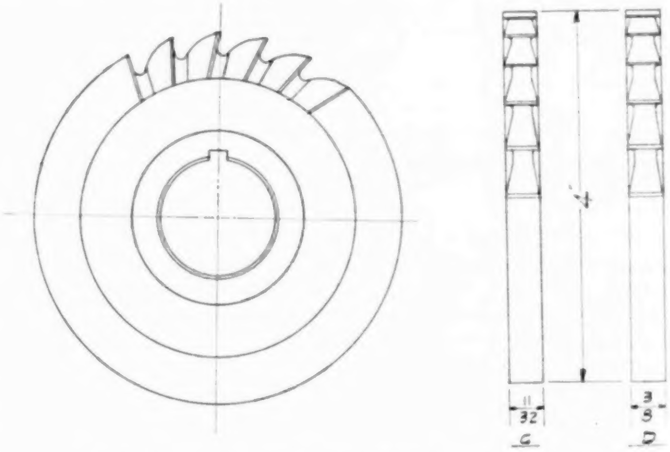


Fig. 2 Standard and Special-Size Milling Cutters

Necessarily the cost of producing must be reflected in the cost to the consumer. Pursuing this line of thought, it becomes evident that the high cost of special tools is eventually levied against the manufactured articles on which the tools are used, and in turn is passed on to the purchaser of these articles.

Let us suppose that a certain operation requires a special milling cutter costing \$30 and that the life of this cutter is 4800 pieces. If we are able to adapt this same operation to the use of a standard milling cutter of approximately the same dimension we shall have effected a considerable saving. This latter cutter can probably be bought for about \$18.

The tool cost for one operation is then reduced from \$6.25 to \$3.75 per thousand pieces. With a great number of machine operations on which such savings may be effected, it is easily conceivable that the results may mean the difference between a possible business loss and a tidy profit at the end of the year.

Elimination of Special Tools

It has already been stated that the total elimination of special tools is impracticable, for there will always be conditions now and then where a standard tool cannot be used; but there can be no doubt that the number of special tools used in the average manufacturing plant, with a little foresight, can be greatly reduced. Engi-

neers and designers responsible for the design of both the manufactured product and of the various jigs and fixtures, must be brought to realize the great economic advantage of standard tools over special tools. Especially is this true where production of large quantities of duplicate parts are involved.

A jig or fixture is a comparatively permanent thing, while cutting tools are in many cases very short-lived. Therefore a small additional expenditure, in order to adapt such jig or fixture to the use of standard tools, eventually becomes a highly profitable investment.

Numerous cases can be mentioned where such simple expedients as the shortening of a jig bushing or the slight reduction in height of some projection on a milling fixture will mean from 20 to 50 per cent reduction in tool costs for that particular operation, inasmuch as it will permit the use of standard tools.

From the author's own experience in the manufacturing of automotive parts there come to mind, too, several instances where the factory, in order to get out the required production, was compelled to ask the engineering department to alter its designs sufficiently so that practical and economical cutting tools could be used. It is a regrettable fact that many engineers, either through ignorance of, or through failure to attach sufficient importance to, small-tools requirements, are in this way wasting money that legitimately should be used either to reduce the cost of the goods or to pay a profit on the invested capital, as the case may be.

Technical schools and colleges would render a real service to the metal-working industries if they were to include in their machine shop curriculum at least a limited amount of instruction along these lines.

It may be properly argued that some of the tools now embodied in the tool manufacturer's standard list do not represent the highest degree of efficiency, and that there are certain other tools, now regarded as special, which will give better results. This is a sound and logical development of the small-tool industry, a development which should be encouraged through the elimination from the standard tool list of obsolete styles and designs, and the substitution of tools, developed through experience and research, that have proved more efficient under all conditions.

We have, for instance, the matter of numbers of teeth in milling cutters and numbers of flutes in reamers. The majority of manufacturers maintain a fair uniformity in this respect, based more or less on practical experience. However, materials and machine-tool equipment are being developed which in many cases demand numbers of teeth or flutes varying from the old established standard. As a consequence many users of tools are specifying numbers of teeth according to their own pet ideas. Obviously this at once classifies the tools as special, because it is impossible for the manufacturer to anticipate consumers' whims.

It seems reasonable to assume, though, that there is one number of teeth or flutes which in general will work most satisfactory. It is in cases such as these that standardization becomes important from an economic point of view.

If standards can be established, and these adhered to, the consumers will derive great benefits through the elimination of expensive special tools and the substitution of more moderately priced standard tools.

For the general good of the metal-working industries as a whole, a program of standardization should be carried out. Attempts should be discouraged to capitalize by attributing fancied advantages to minor construction details and charging special-tools prices for those which legitimately are standard. Standardization will undoubtedly go far toward the total elimination of such practices.

REDUCTION IN THE NUMBER OF STANDARD TOOLS

It is also believed that a material reduction in the number of tools now regarded as standard can be effected without hardship to any one.

A majority of the tools used in the metal-working industries today are made from high-speed steel. They are consequently expensive, due to the high cost of the raw material. When it is remembered that a small-tool manufacturer must carry in stock some 5,000 to 10,000 items of these tools, each in sufficient quantities to care for the possible requirements of the trade, it is easily seen that this imposes on him a large overhead, merely as interest on the investment involved. Therefore, the elimination of a number of items will mean a corresponding decrease in the price of those remaining. Some suggestions are given here, which if followed will accomplish much in this direction. It is at least hoped that these suggestions may serve as a basis for future action. The actual carrying out of the changes proposed must of course be left to the tool manufacturers, but they can do so only after the consumers have been educated to the great economy made possible.

Let us first consider the ordinary straight-shank twist drill with which every one is familiar. In the sizes up to and including 1/2 in. diameter we find from Tables 1 to 4, inclusive, 166 standard sizes listed, as follows:

Straight-shank wire drills	80
Straight-shank letter-size drills	26
Straight-shank drills—jobbers' lengths	31
Straight-shank drills—taper-shank lengths	29
Total	166

TABLE 1 STRAIGHT-SHANK WIRE DRILLS

No. by Gage	Decimal Diameter	No. by Gage	Decimal Diameter	No. by Gage	Decimal Diameter	No. by Gage	Decimal Diameter	No. by Gage	Decimal Diameter
80	0.0135	64	0.0360	48	0.0760	32	0.1160	16	0.1770
79	0.0145	63	0.0370	47	0.0785	31	0.1200	15	0.1800
78	0.0160	62	0.0380	46	0.0810	30	0.1285	14	0.1820
77	0.0180	61	0.0390	45	0.0820	29	0.1360	13	0.1850
76	0.0200	60	0.0400	44	0.0860	28	0.1405	12	0.1890
75	0.0210	59	0.0410	43	0.0890	27	0.1440	11	0.1910
74	0.0225	58	0.0420	42	0.0935	26	0.1470	10	0.1935
73	0.0240	57	0.0430	41	0.0960	25	0.1495	9	0.1960
72	0.0250	56	0.0465	40	0.0980	24	0.1520	8	0.1990
71	0.0260	55	0.0520	39	0.0995	23	0.1540	7	0.2010
70	0.0280	54	0.0550	38	0.1015	22	0.1570	6	0.2040
69	0.0292	53	0.0595	37	0.1040	21	0.1590	5	0.2055
68	0.0310	52	0.0635	36	0.1065	20	0.1610	4	0.2090
67	0.0320	51	0.0670	35	0.1100	19	0.1660	3	0.2130
66	0.0330	50	0.0700	34	0.1110	18	0.1695	2	0.2210
65	0.0350	49	0.0730	33	0.1130	17	0.1730	1	0.2280

TABLE 2 STRAIGHT-SHANK LETTER-SIZE DRILLS

Size by Gage	Decimal Diameter	Size by Gage	Decimal Diameter	Size by Gage	Decimal Diameter
A	0.234	J	0.277	S	0.348
B	0.238	K	0.281	T	0.358
C	0.242	L	0.290	U	0.368
D	0.246	M	0.295	V	0.377
E	0.250	N	0.302	W	0.386
F	0.257	O	0.316	X	0.397
G	0.261	P	0.323	Y	0.404
H	0.266	Q	0.332	Z	0.413
I	0.272	R	0.339	..	...

TABLE 3 STRAIGHT-SHANK DRILLS, JOBBERS' LENGTHS

Diameter, Inches	Decimal Diameter	Diameter, Inches	Decimal Diameter	Diameter, Inches	Decimal Diameter	Diameter, Inches	Decimal Diameter
1/32	0.03125	5/32	0.15625	9/32	0.28125	13/32	0.40625
3/64	0.046875	11/64	0.171875	19/64	0.296875	27/64	0.421875
1/16	0.0625	3/16	0.1875	5/16	0.3125	7/16	0.4375
5/64	0.078125	13/64	0.203125	21/64	0.328125	29/64	0.453125
3/32	0.09375	7/32	0.21875	11/32	0.34375	15/32	0.46875
7/64	0.109375	15/64	0.234375	23/64	0.359375	31/64	0.484375
1/8	0.125	1/4	0.250	3/8	0.375	1/2	0.500
9/64	0.140625	17/64	0.265625	25/64	0.390625	..	......

TABLE 4 STRAIGHT-SHANK DRILLS, TAPER-SHANK LENGTHS

Diameter, Inches	Decimal Diameter	Diameter, Inches	Decimal Diameter	Diameter, Inches	Decimal Diameter	Diameter, Inches	Decimal Diameter
1/16	0.0625	3/16	0.1875	5/16	0.3125	7/16	0.4375
5/64	0.078125	13/64	0.203125	21/64	0.328125	29/64	0.453125
3/32	0.09375	7/32	0.21875	11/32	0.34375	15/32	0.46875
7/64	0.109375	15/64	0.234375	23/64	0.359375	31/64	0.484375
1/8	0.125	1/4	0.250	3/8	0.375	1/2	0.500
9/64	0.140625	17/64	0.265625	25/64	0.390625	...	......
5/32	0.15625	9/32	0.28125	13/32	0.40625	...	......
11/64	0.171875	19/64	0.296875	27/64	0.421875	...	......

TABLE 5 PROPOSED STANDARD FOR STRAIGHT-SHANK DRILLS

Symbol	Decimal Diameter	Symbol	Decimal Diameter	Symbol	Decimal Diameter	Symbol	Decimal Diameter	Symbol	Decimal Diameter	Symbol	Decimal Diameter
80	0.0135	1/32	0.0313	50	0.0700	31	0.1200	7/32	0.2187	25/64	0.3906
79	0.0145	66	0.0330	49	0.0730	1/8	0.1250	1	0.2280	13/32	0.4062
1/64	0.0156	65	0.0350	5/64	0.0781	29	0.1360	15/64	0.2344	27/64	0.4219
78	0.0160	63	0.0370	46	0.0810	9/64	0.1406	0	0.2420	7/16	0.4375
77	0.0180	61	0.0390	44	0.0860	25	0.1495	1/4	0.2500	29/64	0.4531
76	0.0200	59	0.0410	43	0.0890	5/32	0.1562	17/64	0.2656	15/32	0.4687
75	0.0210	57	0.0430	3/32	0.0937	19	0.1660	9/32	0.2812	31/64	0.4844
74	0.0225	3/64	0.0469	40	0.0980	11/64	0.1719	19/64	0.2968	1/2	0.5000
73	0.0240	55	0.0520	38	0.1015	15	0.1800	5/16	0.3125	...	....
72	0.0250	54	0.0550	36	0.1065	3/16	0.1875	21/64	0.3281	...	....
71	0.0260	53	0.0595	7/64	0.1093	9	0.1960	11/32	0.3437	...	....
70	0.0280	1/16	0.0625	33	0.1130	13/64	0.2031	23/64	0.3594	...	....
69	0.0292	51	0.0670	32	0.1160	4	0.2090	3/8	0.3750	...	....

(Continued on page 777)

Power, Paper, Tools and Textiles Featured at Springfield Regional Meeting

New England Engineers Extend Hearty Welcome—Strong Papers Presented—Dean Kimball Broadcasts Important Message—New A.S.M.E. Section Formed

THE ENGINEERS of New England gathered at the Hotel Kimball, Springfield, Mass., on September 25–27, for an absorbing program of technical sessions, excursions and social events. This was the first regional meeting of The American Society of Mechanical Engineers and it was held under the auspices of the Engineering Society of Western Massachusetts and with the coöperation of the Associated Technical Societies of Boston and the A.S.M.E. Local Sections of New England and Eastern New York.

The program for the first day of the meeting was made up of sessions on power in the morning and paper in the afternoon, which were followed by a visit to the Woronoco plant of the Strathmore Paper Company. Here dinner was served and an address delivered by B. A. Franklin, vice-president of the Strathmore Paper Company, on the subject of management. Those not interested in paper were given an opportunity to visit the plant of the Fisk Rubber Company at Chicopee Falls. Dinner was also served and a talk on Rubber and Tire Manufacture was given by William Jameson.

The two simultaneous sessions on tools and textiles held the second morning of the meeting were followed by a luncheon at which the members of the Council of The American Society of Mechanical Engineers were the guests of honor. Mr. Charles L. Newcomb, chairman of the Regional Meeting Committee, presided, and informal addresses on subjects of interest to local engineers were made by Dean Dexter S. Kimball, President A.S.M.E.; J. L. Harrington, President-elect A.S.M.E.; Dr. H. C. Emerson, President Engineering Society of Western Massachusetts; Fred J. Miller, Acting Secretary A.S.M.E., and R. E. Rindfusz, Secretary of the American Writing Paper Company.

Following the luncheon, two automobile parties started, one for the industrial plants of Holyoke and the second to visit the college campuses near Holyoke. Both parties joined at Mt. Tom in time to view the marvelous panorama before sunset. In the meantime, Dean Kimball had gone to the wireless broadcasting station at East Springfield and after the guests were seated at dinner on the mountain they were greeted by a radio message from him.

Dean Kimball's Wireless Message

"I am always rejoiced when I see engineers gathered together for purely social purposes, because then one of the most important functions of the Society is being discharged. We constantly hear the question asked, 'What do I get out of the Society?' That is a fair question and merits a thoughtful reply.

"Engineering societies are somewhat like universities. They offer opportunities in certain directions, and only those who take advantage of these opportunities receive any benefit therefrom. Not the least of these opportunities is the privilege of mingling with fellow-workers in one's chosen field, and with others in allied fields of endeavor. Such intercourse is highly valuable in that it affords an opportunity to evaluate one's own ability and weakness by comparison with others, and such intercourse cannot fail to be mutually helpful in stimulating mental and personal growth.

"An active interest in a great professional society is also very helpful in evaluating the relative importance of the several callings and professions, and in these days of differentiated effort and refined specilization, such clearness of vision becomes increasingly important. Within every such society there are groups that honestly feel that they are the most essential cog in the machinery, and in a larger way this is true of the great congress of trades and callings that constitute industry. Anything that helps in evaluating these many activities is indeed valuable.

"And lastly, in these troubled times when the nations of the earth are seeking new philosophies of life, it is incumbent upon all men to consider carefully what influence their particular calling has had upon this complex thing we call civilization, and what influence this calling may exert in unraveling the tangled problems in which we now find ourselves involved. This applies with peculiar force to the engineer, for this present civilization is largely the work of his mind and hand and the civilization of the future will be largely what he wills it to be.

"In the congresses of engineers only is it possible to gather a concrete idea of what is moving in the minds of those engineers who outline progress and set the pace. The engineer who absents himself from membership in such societies or who, while a member, absents himself from the councils and social gatherings of his fellow-craftsmen, divorces himself from his greatest opportunity for growth and from his greatest opportunity to serve humanity."

The after-dinner program was most happily conducted by H. H. Bowman, President of the Springfield National Bank who was introduced by Dr. H. C. Emerson. The speakers were Mr. Charles L. Newcomb, Chairman of the Springfield Regional Meeting Committee, J. L. Harrington, President-elect of the A.S.M.E., Fred J. Miller, Acting Secretary of the A.S.M.E., and George E. Williamson, President of the Technical Association of the Paper and Pulp Industry. Music was rendered by the Deane Singing Club of Holyoke.

During the evening the members of the A.S.M.E. in Western Massachusetts were advised that their petition for the formation of a Local Section had been granted. An organization meeting was held and the following members were elected to serve on the Executive Committee until the end of the Society year: Chairman Charles L. Newcomb, Holyoke; Vice-Chairman George E. Williamson, Springfield; A. L. Bausman, Springfield; F. O. Wells, Greenfield; A. H. Blaisdell, Pittsfield. Robert W. Mitchell, Secretary and Treasurer of the Engineering Society of Western Massachusetts will also act as secretary of this new Section.

Appreciative mention should be made of the committees who planned the events, who offered a whole-hearted welcome to the guests and who conducted the ceremonies in a most effective manner. The Executive Committee was composed of Chas. L. Newcomb, Chairman, Geo. E. Williamson, Vice-Chairman; Dr. H. C. Emerson, J. Playdon, Jr., Secretary, Wm. G. Starkweather, W. B. Lewis, H. W. Dunbar, M. C. Nelson, Prof. S. W. Dudley, Stillman Shaw, H. E. Harris, C. K. Decherd, C. M. Flagg, B. S. Lewis, S. S. Roby, R. O. Ackerman, and J. J. Crain. The chairmen of the other committees were: Program and Meetings, A. S. Hall; Entertainment, Dr. H. C. Emerson; Publicity, Dr. R. E. Rindfusz; Reception, C. C. Chesney; Finance, John C. Robinson: Registration, Arrangements, Information, A. L. Bausman; Transportation, A. L. Trudo, and Invitations, G. E. Williamson.

Session on Power

The opening event of the meeting was the Session on Power, which was called to order on Monday, September 25 at 10.00 a.m. in the Hotel Kimball. Mr. Charles L. Newcomb, Chairman of the Regional Meeting Committee greeted the guests, introduced the various officers and committee chairmen and then retired in favor of the presiding chairman for the session, Mr. C. C. Chesney, Manager and Chief Engineer of the Pittsfield Works of the General Electric Company.

The first speaker was Mr. R. A. Packard, Superintendent of Power and Shops of the Ludlow Manufacturing Association, whose paper was entitled Multiple Source of Power for Reliable Large Industrial Plant Operation. Mr. Packard emphasized the importance of continuity in industrial power-plant operation and in closing stressed the need for correct design of multiple source of power, proper installation, and efficient maintenance and operation. Mr. Packard's paper describes the power installation at Ludlow, designed especially for continuity of operation. It is given below, slightly abridged.

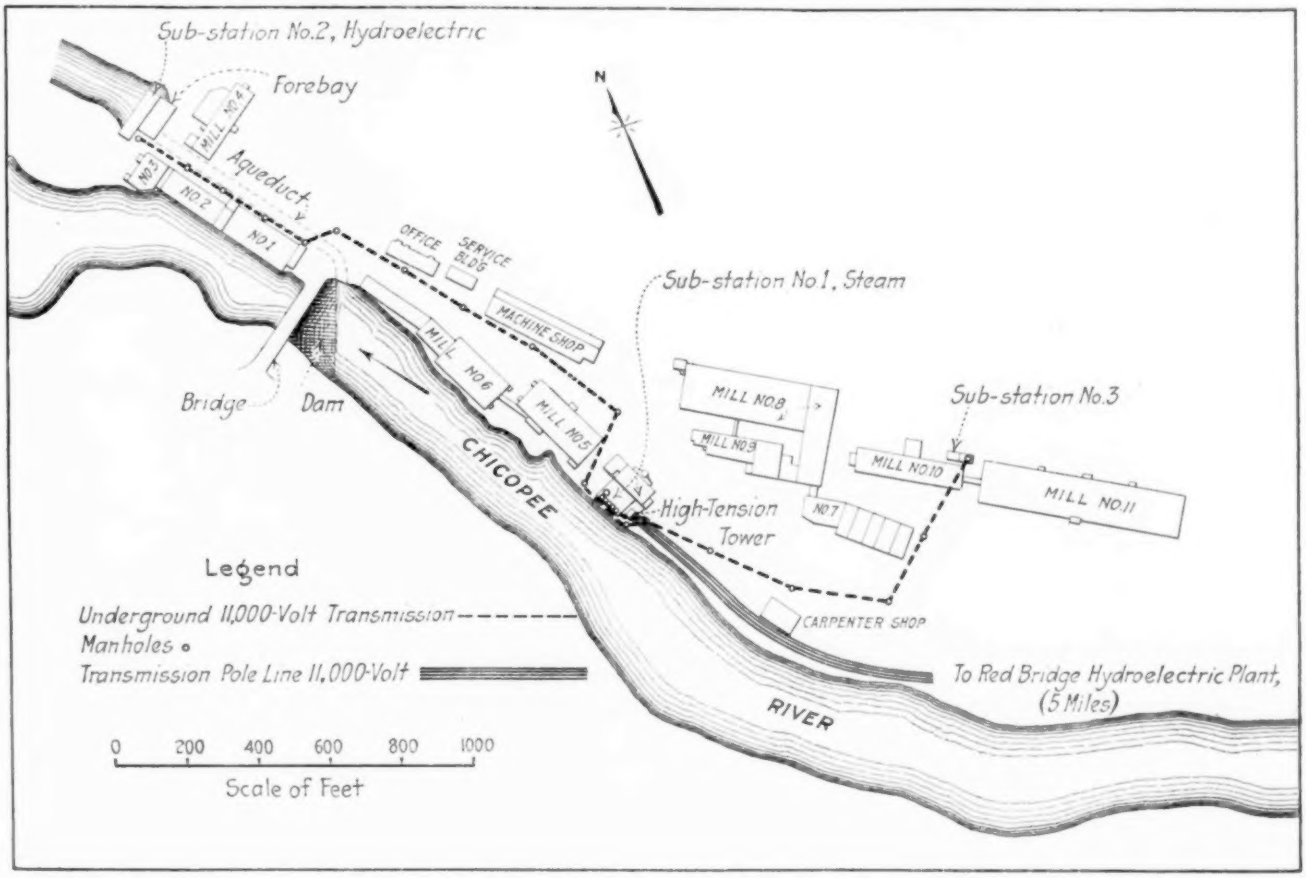
Multiple Source Power for the Ludlow Manufacturing Associates

In the generating, transmission and distribution of power for the Ludlow Manufacturing Associates in Ludlow, Mass., natural conditions have contributed largely to a satisfactory arrangement. The sustained flow of the Chicopee River at Red Bridge, 5 miles above the plant, affords a 50-ft. fall for several thousand kilowatts over a majority of the months of the year. Similarly, a modern hydro development at Ludlow in the mill yard delivers power under a 40-ft. head from the same water passed at Red Bridge. The steam power station, also located in the mill yard, acts as standby equipment, the building affording room for a central connecting point of the 11,000-volt transmission lines from the two hydroelectric plants. This latter building also serves as a substation for 550-volt distribution to the nearby mills. A substation in the mill yard hydro-plant also distributes 550-volt power service. From the steam power plant there is an underground 11,000-volt connection to the substation No. 3, where transformation to 550-volts supplies power to the largest group of mills. In this substation is a frequency-changer set, to reduce the Turners Falls Power Company's power from 60 to 40 cycles.

The Red Bridge plant has a water-storage reservoir of 185 acres, while the plant in Ludlow has but 62 acres. With these plants 5 miles apart, it is possible by manipulation of the water to keep the smaller lower reservoir from dropping too low under heavy power demand. The usual arrangement is to pull heavily on this plant when the mills start in the morning, to save water from wasting over the flashboards. At about 10 o'clock the water which passed Red Bridge at 7.30 commences to reinforce the reservoir at Ludlow. When the river flow runs low, the load at the Ludlow hydro-plant must necessarily be cut down until sufficient supply of water has reached it from Red Bridge. On such days, during the last two hours of the afternoon, the load on the former plant is increased to draw the water as low as possible so as to allow a single all-night service unit in operation at Red Bridge to fill up the restricted Ludlow reservoir.

Of far more significance is the continuity of power service which this system upholds. An interruption of power in all the mills practically never happens. Whenever it does, it is more of a surge of frequency and voltage than anything else, due to a disturbance on some leg of the system. An accident at one plant may automatically dump its load to the remaining sources of power. Interruption of power service on a particular mill group never lasts more than two minutes, so flexible is the system for handling the situation. The correct design and proper control and overload protection have been installed along with correct designs for transmission and distribution. A dead short-circuit across one of the transmission lines, a breaking down of the insulation in the field coils of the 40-cycle end of the frequency-changer set, or lightning surge in the transmission line have given a minimum of trouble. Take, for example, the most severe test which any transmission system has been called upon to stand during the last few years—that of the hail and ice storm of Dec. 5, 1921. This storm carried both transmission lines down, due to high trees laden with ice which dropped across the wires. It was thought the "cut-back" along the line had been sufficient to include these particular trees, but the severity of the storm wrought havoc in a most uncanny manner. The three remaining sources of power at Ludlow were compelled to bear the burden of the load, allowing the mills to proceed with the usual program of production without much interference. The heating system in the mills was shut off and turned into the steam turbine. The temperature outside was not so cold that the heat given off from the process steam and electric power was not sufficient to maintain the rooms at a temperature reasonable under the unusual temporary conditions.

There are factories or mills which do not have the above described unique possibilities of feeder and station arrangement. In such properties, full significance should be given to the proper design and installation of a power system allowing ample transmission capacity for the expansion of the plant. It is much better to have provision for more than one main feeder, so that without disturbing cables already installed, additional capacity can be



Map Showing Multiple Sources of Power for Ludlow Manufacturing Associates

placed in multiple with them. Care should be given to secure sufficient carrying capacity to allow uninterrupted service should a cable burn out. A proper installation should consist of well-made joints and firmly secured conduits or cables. One weak link in the system may affect the efficiency of the whole. Many large industrial plants have their own centrally located steam power stations. From the point of view of economy of distribution of steam and power, the proposition is good; the unique and clever designs of stations and the almost perfect development of machinery and apparatus have gone a long way toward securing reliability of operation, but it cannot quite equal a multiple source of power where failure of one automatically, or nearly automatically, calls on the other to support the load.

Some time ago, the Ludlow mills were served with an isolated boiler plant near the Ludlow hydroelectric plant, a left-over of the old-time, slow-speed Corliss Engine days. It had served its usefulness and was torn out. Concentration of steam generation can be most efficiently handled at the main steam plant. This illustrates conditions which have existed in other growing plants, the tendency in having too many sources of power both for steam and electricity, which when reduced in number and remodeled, have conduced to greater reliability and economy.

Once an ideal system of generation and transmission from a multiple source is in operation, its personnel of operation, inspection and maintenance is of great importance. A definite periodical examination of generating, transforming and distributing equipment is of prime importance. The cleaning and inspection of compensators will save heavy dividends. A large number of motors necessarily must be started and stopped by ordinary mill hands. No one should be allowed to handle such apparatus without first having been carefully instructed and without passing an examination satisfactory to the electrical maintenance foreman.

R. J. S. Pigott, works manager of the Crosby Steam Gauge and Valve Company, Boston, Mass., followed Mr. Packard with an address on Economies in the Use of Fuel. In his opening remarks, Mr. Pigott discussed the question of central-station power for the isolated plant and emphasized the difficulty of even stating fundamental principles that, without qualifications, would guide in the choice between the isolated plant and central-station service. He stressed the need for considering each problem on its individual merits and deciding on the basis of cheaper power costs. He also pointed out the necessity for the economical layout of piping systems, the use of stokers even in one-man plants, the operation of hammers by compressed air, the centralizing of air compressors and the intelligent installation and use of recording and indicating instruments if a proper economical operation is to be attained in the industrial plant.

The discussion at this session centered on the relative reliability and economy of the private plant as compared with the central station. This led to a consideration of the use of steam-metering devices, and R. E. Woolley, of the Schenectady Works, General Electric Company, told of the careful records that are kept by the 160 steam-flow meters in the shops of that company. The steam used in each shop is metered, totaled, and subtracted from the total steam produced. The remainder represents the losses, which are scrutinized carefully. Any variations in this figure lead to investigations and inspections.

Session on Paper

Mr. George E. Williamson, chief engineer of the Strathmore Paper Company, and president of the Technical Association of the Paper and Pulp Industry, presided at the session on Paper which was held Monday afternoon, September 25, in the Hotel Kimball. Two papers were presented—one on Applying Engineering Principles to the Selection of Paper, by Dr. R. E. Rindfusz, secretary of the American Writing Paper Company, and one on Steam Utilization in a Modern Newsprint Mill, by S. W. Slater and J. E. A. Warner, engineer and assistant engineer, respectively, of the St. Maurice Paper Co., Ltd., of Cape Madeleine, Quebec.

The paper on Steam Utilization in a Modern Newsprint Mill appeared in the September issue of Mechanical Engineering. An abstract of the paper by Dr. Rindfusz follows:

Applying Engineering Principles to the Selection of Paper

In the manufacturing and distributing of paper, as in any other class of industry, the applying of engineering principles or the using of scientific methods means simply the employment of the best available common-sense—collecting the pertinent facts and building a course of action from them, with an open mind that will allow modification when other or weightier facts may be brought to bear. A brief background of conditions in the paper industry is necessary for an understanding of the need of engineering practice in the selection of paper.

While it is beside the point to present a brief for or against the paper industry as compared with other industries, we of the paper business are forced to admit that in large measure, instead of directing our development in a far-sighted and common-sense manner, we have allowed it to drift. The paper industry has been cursed by a multiplicity of brands, both mill and private, though chiefly the latter. This grew up, perhaps, as a natural evolution. A certain brand of paper, for instance, would be found to have wide use. Some mill or paper jobber would desire to cut into this established business. To do this he would create a new brand closely resembling the other, but slightly lower in quality and price. The maker of the first brand might then fall into the temptation also to cheapen. By constant repetition of this process qualities were rendered unstable, and an immense number of confusing and meaningless brands put on the market. The competition became one of price, and the quality of paper applied to any given use tended gradually downward until it became almost the exception rather than the rule to find the right paper employed in any particular use.

The result of all this confusion in paper qualities and shortsightedness in sales policy has been the fostering of chaotic manufacturing conditions, complex distribution problems, and ineffective service to the needs of the consumer. It is evident, therefore, that engineering principles are needed for remedying this condition.

The chief users of paper have finally become awakened to the inefficient methods of manufacturing and distribution which they have been forced to support, and to the absurdities into which they have been led in their selection of papers. They have, very naturally, therefore, in many cases set up specific specifications based on paper testing. This is open to serious objection because paper-testing methods are not fully developed, and the translation of use requirements into terms of paper tests, and of the paper tests into terms of manufacturing skill, is indeed a difficult and roundabout procedure. The better procedure is for the manufacturer to make his papers each for a specific use, and after he has found a given paper thoroughly satisfactory for its particular use, then to establish his test specifications and employ them for the maintenance of quality. If a complete enough set of test specifications can be developed, they can then be transferred from the manufacturer to the purchaser, who can use them for judging the offerings of various makers.

To an engineer, it is at once obvious that the fixing of each different member of a line of products for a specific use can be possible only where a complete standardization has been brought about. In the paper industry seven phases of this standardization have been established. These are the standardization of:

1 Raw materials
2 Process
3 Product
4 Line (grade standardization)
5 Distribution
6 Price
7 Use.

It is only when the others have been brought about that the seventh phase, which we are now discussing, can become effectively applied.

The method employed in translating each individual requirement of a user into terms of the proper paper is really quite simple. We find that all of these requirements may be grouped under four main factors, namely:

1 Longevity, or the length of time for which the paper must resist deterioration
2 Treatment, or the amount of separating, of handling, fold-

ing, binding, or exposure to which the paper will be subjected

3 Impress, or the mechanical method of applying reading matter, illustrations, decorations, or rulings

4 Appearance, or the character or sense appeal of the paper itself.

The longevity of a sheet depends upon its chemical constituents. If it contains mechanical wood pulp, ground wood, such as we find in newsprint, its life will be only transient; if it is made of chemical wood pulp alone, or in preponderance, its life will be temporary; if of mixed cotton fiber and wood pulp in approximately equal proportions, it may be classed as semi-permanent; and if all, or very predominatingly cotton fiber, it is for all practical purposes permanent. The paper made from cotton rags upon which Gutenberg himself printed the Bible is, as is well known, still extant.

Of the four factors given above, the first three may be rated by physical and chemical tests. An analysis will give the key to the longevity of the sheet. The tensile strength, folding endurance, stiffness, bursting strength, etc., will give an indication of its resistance to severe treatment. Tests of its absorbency, surface, stiffness and opacity, as well as the actual application, will show its suitability for impress. Appearance alone is a sense appeal, and hence subject to personal opinion. Nevertheless, if a paper is to be classed as first grade in its appearance, its sense appeal must be so general as to be recognized by at least nine out of ten average and uninitiated observers. If it does not do this, it would in most cases be a waste of money to buy high-grade paper for the sake of its appearance since genuine paper experts are comparatively rare. The appeal of various finishes, such as the linen finish, or lawn finish, may usually be considered quite general within certain groups of users.

Management in the Paper Industry

Following the visit to the Woronoco plant to the Strathmore Paper Company, B. F. Franklin, vice-president of the company, delivered an address dealing with the general principles of management and their applications to the paper industry. Mr. Franklin stated that any adequate system of management to be successful must have ideals, aims, policies and realizations.

The most important ideal is that of service, as industry not only has the important reason for existence that it renders service to buyers, but also is a focusing device for increasing the service value of individuals engaged in industry. A second ideal is that underlying the desire to make people happy.

The speaker stated the four aims of management to be: profit for the perpetuation and expansion of the industry for service; the payment of fair wages; the manufacture of the best product for a particular use; and the marketing of this product with a fair profit.

The guiding policies of management must be, according to Mr. Franklin: proper selection and training of personnel; reward to employees in proportion to service rendered; maintenance of plant in up-to-minute condition of repair and improvement; and the constant knowledge of details of the business.

Some definite realizations must come from proper ideals, aims, and policies and the speaker treated them somewhat in detail. It must be realized, first, that success in industry is derived primarily from men and not from machinery. Furthermore, after a knowledge of the materials to be used in the industry, there must be a service of well-defined methods which he divided into administrative and technical. Administrative methods must be provided for costs, records of part performances, expense analysis and control, production planning, bonus payment, quality control, and for the human element which has not been properly treated to get the best results. In discussing technical methods, Mr. Franklin pointed out that the paper industry differed from all others in the intricacy of and variations in its processes. He spoke, however, very optimistically of the coöperation progress that had been made in the industry in standardization and development.

Session on Preservation of Wood Roofs

The textile men attending the meeting were very much interested in the paper by Wendell S. Brown, of F. P. Sheldon & Son, Providence, R. I., entitled The Preservation of Decaying Wood Roofs, which appears on page 709 of this issue of Mechanical Engineering. The paper has an important bearing on the roofs of buildings which house processes requiring moisture in the air. The discussion brought out under the chairmanship of Dr. H. C. Emerson, president of the Engineering Society of Western Massachusetts, will appear in the December issue of Mechanical Engineering.

Session on Standardization of Tools

Dr. E. C. Gilbert, works manager of the Chapman Valve Company, presided at the session held Tuesday morning, September 26, when two papers dealing with the standardization of tools were presented. The first paper, by Carl J. Oxford, chief engineer of the National Twist Drill and Tool Company, Detroit, Mich., dealt with the Standardization of Small Tools, and the second, by Fred H. Colvin and K. H. Condit, editors of the *American Machinist*, offered suggestions as to the Standardization of Machine Tools. These two papers appear in this issue of Mechanical Engineering.

On the subject of small tools, W. A. Viall, secretary of the Brown and Sharpe Mfg. Co., of Providence, R. I., in a written discussion agreed fully with Mr. Oxford in the statement that manufacturers' lists of small tools can be greatly reduced. Mr. Viall expressed surprise at the great demand for special tools which may vary but slightly from tools of standard dimensions, and he gave twenty-one items from a day's orders for cutters which varied by only small amounts in diameter, arbor size, and thickness from the stock article. His discussion closed with an especially strong plea for careful study by tool users of the lists of standard tools produced by tool manufacturers and the formulation of design, that will permit the use of standard small tools.

F. O. Wells, of Greenfield, Mass., emphasized the importance of small-tool standardization. He felt, however, that manufacturers and users must come together to determine real needs and to agree upon possible elimination in lists of manufactured small tools.

Arthur F. Murray, of the Westinghouse Electric and Manufacturing Co., Springfield, treated the subject from the standpoint of the user of small tools. He found that even with the large list of tools available for the manufacturer it was necessary for him to design special tools. Mr. Murray stated that designing engineers should be more familiar with methods for utilizing standard tools by reworking them for special use.

Elmer H. Neff, of the Brown and Sharpe Manufacturing Co., New York, stated as his opinion that the buyer must dictate as to the tools he requires. He disagreed with the idea that manufacturers could, without coöperation with the user, eliminate any of the list of tools to be supplied by a manufacturer of small tools.

Selby Haar, electrical and mechanical engineer, New York, agreed with the idea of treating special tools as modifications of standard tools.

Frank B. Gilbreth, consulting engineer, Montclair, N. J., spoke from the standpoint of one who has occasion to study the manner in which various manufacturers store their tools. Generally he found that there was a lack of a clear idea of the proper uses of the various tools, and that each user wanted something different. The standardization not only of small tools and machine tools but of every kind of a tool would produce tremendous savings in production costs.

In the discussion on Standardization of Machine Tools, Luther D. Burlingame, of the Brown and Sharpe Manufacturing Co., Providence, submitted a written discussion in which he endorsed heartily the manner in which Messrs. Colvin and Condit treated the principles of machine-tool standardization. He emphasized the principle that standardization is often a matter of elimination and also that it is useless to adopt theoretical standards which manufacturers and users will ignore. Where these two principles are followed, standardization does not hamper progress.

Mr. Burlingame recommended the adherence to the Morse and Brown and Sharpe tapers. In adopting standards for shafting keys he suggested that flat keys be eliminated for small sizes and square keys for large sizes. In the matter of screw threads Mr. Burlingame advocated the adoption of such threads as could be agreed upon by both Great Britain and America on a common standard based on the inch.

Governor Hartness Emphasizes Evils of Industrial Strife

Chief Executive of Vermont Discusses Problems of a Machine-made Civilization at Machine Tool Exhibition at New Haven, September 21-23—Messrs. Buckingham and Wikander Stress Standardization Principles—12,000 Appreciative Visitors See 135 Novel Machine Exhibits

BESIDES furnishing an array of interesting and novel exhibits of machine tools and machine-shop devices to over 12,000 visitors the New Haven Machine Tool Exhibition held September 21-23 in the Mason Laboratory provided a platform for a number of instructive addresses. Governor James Hartness, of Vermont, Past-President of the A.S.M.E., spoke very forcibly of the far-reaching influence of machine tools on present-day civilization and pointed out the need for constructive thought about future problems. The importance of standardization was stressed by Oscar R. Wikander, consulting engineer of New York, who told of the progress of German standardization and by Earl Buckingham, of the Pratt & Whitney Co., Hartford, Conn., who outlined fundamental standardization principles for precision production. Another interesting talk was given by Oswald W. Knauth, Secretary of the National Bureau of Economical Research, who presented some facts about individual incomes in the United States. Governor Hartness' remarks appear in full below as do liberal abstracts of the talks by Messrs. Knauth, Wikander and Buckingham. Other speakers were Henry B. Sargent, President of the New Haven Chamber of Commerce, who extended the greetings of the city to the exhibitors and visitors, Dean Charles Warren, Sheffield Scientific School, who spoke on Coöperation between Colleges and Industry and M. S. Liming, Manager of the Boston Chamber of Commerce who told of the Outlook for Industry in New England. In addition, William Calkins of Detroit described the design, manufacture and performance of twist drills and Gardner T. Swarts, Jr., of Providence, R. I., demonstrated an application of Graphic Control to Machine Tool Manufacture. A number of motion pictures were shown.

The 135 exhibits elicited so much favorable comment that the exhibition is being seriously considered as a permanent annual affair. The coöperation of the authorities of Sheffield Scientific School who permitted the use of Mason Laboratory and of the New Haven Chamber of Commerce who assisted whole heartedly in the arrangements should receive special mention. The success of the exhibition is due to the efforts of the Exhibition Committee and the Executive Committee of the New Haven Branch Connecticut Section of The American Society of Mechanical Engineers which assumed major responsibility. The names of the men who made up these committees are K. F. Lees, Chairman Executive Committee, H. R. Westcott, Chairman Exhibition Committee, A. C. Jewett, N. E. Horn, A. L. Breitenstein, G. A. Stetson, F. W. Shatts, S. W. Dudley, H. L. Seward, W. L. Bean, H. Gfroerer, Wm. Buxbaum.

INFLUENCE OF THE MACHINE TOOL IN AMERICA

By JAMES HARTNESS,[1] GOVERNOR OF VERMONT

THE machine tool has been a wonderful instrument in extending the efforts of man, in amplifying the product that he could turn out. The machine tool, as all know, is the father of machinery, and as such it is largely responsible for the serious condition that confronts us today.

One hundred years ago, or even fifty years ago, the world was a very different place from the world we have today. Then work was done more by hand, and nearly all families were more or less self-supporting in producing the things that they needed. Their own food they would grow, and make their own shoes, perhaps, and so on through the whole range of the necessities. Men worked hard to produce the bare necessities of life.

With the introduction and development of the machine tool and its product, machinery, man's efforts now produce in many instances a thousand times the value that was produced before he was aided by this machinery.

At the present time we are facing the result of the strikes in the coal mines and on the transportation systems, and we are learning, none too early, that our whole scheme of management of our industrial affairs, our financial affairs, and our business affairs, fails to keep pace with the development of the world as it has grown under the work of the machine tool and its products.

Our Government, which originally confined itself for the most part to maintaining peace within the state and uniting us against a foreign enemy, is now trying to handle matters of business, matters of engineering, matters of farming, matters of finance, with men elected to office by the popular ballot; and it is impossible to conceive of a quicker way to wreck a business or manufacturing concern, than to put it in the hands of men chosen in that manner.

Our constitution is undoubtedly the best in the world, and I would not propose the making of any material changes in it, but it is best for us to realize that something must be done to head off the danger that is threatened. At the time this Government was formed, when we declared our independence, there was not one-half of the danger to civilization that there is today. Then dangers were more easily seen. Today these forces are working within our own country.

We know well enough that one of the greatest misfortunes to our country is the interruption of work by strikes. These strikes are the result of conditions that should not exist. In some cases the men must strike to get a fair wage. On the other hand, men sometimes strike for more than a fair wage because they have been led to believe that they are entitled to more and that the larger portion is their just due; or possibly they have been told that the men managing the business have been handling it for their own personal good and have taken for themselves more than a just return, and that they—labor—have the same right to get out of it all they can, and by whatever means are necessary.

We know at the present time that the cities can be starved. We know that we can increase the death rate and increase suffering in them by shutting off transportation. We know that it is simply a matter of time when this will be done unless we who have built up this wonderful fabric, this wonderful machine, give some attention to regulating these matters.

We think we are a great people, and we point to the success we have achieved in various directions, yet our development has been along lines so narrow that we have failed to understand the bigger problems.

The doctors disagree as to what we should do. All who are doing essential work are necessary, but we can not agree at what is a fair adjustment of matters. We are going on using force, fighting, and in many ways interrupting the production of values before we get to the point of dividing them. This interruption of production reduces the amount that is to be divided. A strike makes it more difficult and more impractical for a manufacturer to pay higher wages. Yet we go on by this process of fighting, which is absolutely wrong.

We know what the conditions are under which working units produce the greatest value. The wonderful organizations such as are found in Connecticut and in the more highly developed industrial regions show clearly what is the best scheme to employ, yet we fail to put it in effect. Are we incompetent to arrive at some way of doing this? If we are, then our Government will not endure. If we are to be the strongest as a military nation in defending ourselves in war, to win out in the conquest of peace we must see to it that we so order our lives that men produce the

[1] Past-President, The American Society of Mechanical Engineers.

greatest value, and that the whole country functions as we know it should function.

We know it is wrong to force men to strike for a rate of pay that is their just due, and that it is equally wrong for them to strike for more than their share. If one department is being paid higher than another it enslaves the one getting the lower pay. We shall never settle this matter equitably, however, unless we arrange to accomplish it by some other means than fighting.

There is a way to do that. We have a representative form of government, and our representatives at Washington and at our state capitals react readily to public opinion. They are ready to give what the people demand. How can we get them then to see the light? We can do it by having the light seen by the people; every worker in every division must first learn that strikes and other interruptions to our production are harmful to the whole country, that there is less value to be divided when less is produced, and that whatever means are adopted to make an equitable division, there must not be an interruption of production. Every one will agree to that.

There is no hope of gett ng justice by depending on agricultural blocs, on various associations of the various interests, federations, and other groups. They simply fight to get the largest share possible. Then what shall we do? We must go back to the commission type of arbitration. It is true that this has been a failure in the past. Our laws would have gone wrong, however, if it had not been for our constitution and our arbitration will go wrong unless there is some scheme devised by which men sitting on such boards start not only as impartial members, but hold strictly to the letter of the economic law as it applies to our industrial life of today.

This is simply carrying out the principle of arbitration by boards functioning under a code that can be easily drawn by civilians when the deduce from our present practice a code of regulations that will define and limit the activities of those boards. Then we should have a board that would say whether the miner was getting more than his share, or the bootmaker, or this or the other worker. There would be taken into account the energy and initiative of invention as applied to business matters as well as machine design, and all those things that count for progress. There would be taken into account the spirit of the organization, the spirit of the management. There would be valued all those things that are valued today.

We must face this question, and so tonight while I might have talked about some other points, I wanted to bring out to my friends at Yale, my engineering friends, and the people of Connecticut, the fact that the machine tool that has built up this wonderful world of mechanism has also built up something truly menacing. We shall be strangled by interruption to our transportation, and unless we use our brains in adjusting this matter along lines far different from those followed at the present time, it will go very bad for civilization; it will go very bad for America, especially if Germany or some other country is found to be working truer to the laws of human industrial economics.

INCOME ANALYSIS IN UNITED STATES

By OSWALD W. KNAUTH,[1] NEW HAVEN, CONN.

A GROUP of men who served on the War Industries Board, and after the war came to the conclusion that what was needed in economics was more facts, proceeded to found an association called the National Association of Economic Research for the purpose of finding facts and giving all a basis from which to reason. This association has an extraordinarily unique group of directors. There are nineteen of them, varying from labor leaders to capitalists, and everything that goes out from the bureau must be scrutinized and passed on by them.

It was with the object in view of not only finding out what the income of the country was, but of finding it in such a way that no one could disregard it that this kind of association was formed, and the research made recently which resulted in our determining the variations in income during the last decade.

The question of the amount of income in the country is mainly important in determining whether or not the standard of living in the country can be raised. We have been having an insistent demand that the standard of living should be raised. Now, can it be increased? Will an increase in wages really increase the standard of living or will it simply raise prices? Is there enough being produced; for after all, we cannot use that which is not being produced. What share of the total production goes to so-called capital and management, what share to so-called labor? These are all questions on which we have had very little exact information.

We defined income as the money paid for the commodities and services of the country with the omission of things for which no price is commonly paid. That omission includes mostly housewives' labor, which probably should be included. But after all, any price one chooses to assign to the items omitted would be purely arbitrary, and we tried to stick to facts.

We found the income of the country was roughly \$32,000,000,000 before the war, and that it rose with increase in prices to \$54,000,000,000 in 1917, to \$61,000,000,000 in 1918, to \$66,000,000,000 in 1919, and to about \$70,000,000,000 in 1920; and that this increase was entirely, or very largely, due to a rise in prices and not to an increase in the amount of commodities that were produced. This was shown when all these sums were made into uniform dollars. The expression "uniform dollar" means the value of a dollar on the basis of 1913. During 1916 to 1918 production increased greatly and in terms of 1913 dollars amounted to from \$38,000,000,000 to \$40,000,000,000. In other words it increased by about 20 per cent over the figure of \$32,000,000,000 of prewar years. Since the war it has decreased about 10 per cent so that for 1920 and 1921 the figure should be about \$37,000,000,000. In terms of per capita production this means \$350 before the war, \$400 during the war, and \$360 to \$370 in the years since the war. The Bureau as such does not interpret these figures. A number of people, however, have interpreted them and they have all come to the conclusion that they showed definitely that the economic problem in this country is not one of redistribution, is not one of taking away from those who have and giving to those who have not. Anything in that direction would be a mere pittance, and would do practically no good. Our real problem is one of increasing the goods that are produced if we are going to increase the amount of comfort that the people in this country are to have.

We went a step further than that and made a table showing the number of persons having incomes of the various sizes. We have 37,500,000 people in the country earning incomes. Of these 27,000,000 earn less than \$1500 annually. If we call the middle class between those having incomes of between \$2,000 and \$10,000, there are about 5,000,000 in that class or about 15 per cent of the total. If we call the upper class those whose incomes range from \$50,000 up, there are from 20,000 to 25,000 in that class. If we should confiscate the income of these 20,000 to 25,000 people we would be confiscating about 5 per cent of the national income. In other words we should be increasing the income of all others about 5 per cent which obviously would not make a very great difference.

The great bulk of our incomes—those of about two-thirds of the number of persons who receive them—are between \$500 and \$1500. There are several other interesting things. The normal distribution of income between capital and management on one hand and labor on the other is 30 per cent to capital and 70 per cent to labor. In 1918 this changed to 77 per cent to labor and 23 per cent to capital. In 1919 it was about the same. The 1920 figures are rather puzzling on account of the tremendous shifts in prices in that year, and we have not yet established the proper way to handle them.

The share of the national income actually paid in the form of wages is about 50 per cent of the total. That is not the whole share that goes to labor, however, for many people perform hand labor and receive some form of profits in place of wages while many people who do not perform hand labor receive wages.

Before the war, five per cent of our people received about thirty-three per cent of our national income. In 1919 that figure was reduced to twenty-four per cent and in 1920 it was still lower.

Undoubtedly the distribution of income is closely connected with the mysterious currents which we have learned to call business cycles. At the request of Mr. Hoover the Bureau of Economic Research has made some studies, but we have come to the conclusion that we are only at the beginning of real knowledge of the things effecting business movements.

[1] Secretary, National Bureau of Economic Research.

GERMAN INDUSTRY'S NEW EXPORT POLICY BASED ON STANDARDIZATION

By OSCAR R. WIKANDER,[1] NEW YORK, N. Y.

BEFORE the war the efforts of standardization in Germany were mostly confined to manufacturer's associations, and systematic efforts to obtain national standardization were the exception.

At that time the progress of standardization in Germany was greatly handicapped by the policy of German exporters to offer to sell a customer anything he wanted. Reports from our commercial agents in all exporting countries ten to fifteen years ago point out very strongly that the strength of German competition was due to this fact. If a man wanted to buy shovels with green blades and red handles, the Germans would furnish them that way, while the American firms would point out that the product of their company was so and so and the customer could either take it or leave it. Such a policy was obviously very harmful to any development of a standardization procedure, either national or international.

It took the war to arouse the German manufacturers to the enormous economic advantages to be gained by industrial standardization on a national scale, and it can therefore be said that standardization in Germany on the scale on which it is being carried out at the present time dates from the war.

Under the auspices of the Verein Deutscher Ingenieure, the Normenausschuss der Deutschen Industrie, which corresponds to the American Engineering Standards Committee, was formed and has since its organization established a great number of national standards. The Normenausschuss now represents the departments of the German Government and the principal industrial associations.

This well-organized and comprehensive activity on the part of the Normenausschuss is significant for two reasons. It will simplify and unify the industries of Germany and will thus prepare them to enter international trade again with all their prewar enthusiasm and all the advantages of mass production. The automatic machine tools of the United States and its other labor-saving devices will not alone suffice to meet this new form of competition. American industry must standardize.

When German industry has recovered from the effects of the war and again makes a systematic effort to regain its foreign commerce, the standards which it is now preparing will play a large part in this campaign. An effort will in all probability be made to induce the non-manufacturing countries to adopt their standards commercially thereby insuring among other things general interchangeability. Such adoption would give then an advantage over other exporting countries. British manufacturers with the assistance of the British Government and the British Engineering Standards Association are endeavoring to extend the use of British standards throughout the British Dominions and throughout other importing countries for the great advantages which it will give them in foreign commerce.

The financial and economic conditions of Germany will absolutely compel its industries to export a large part of their production for years to come. It is for this reason that they will endeavor to secure the adoption of their standards and products in foreign countries and will also give support to all efforts to secure the general adoption of international standards.

PRECISION, STANDARDIZATION AND PRODUCTION

By EARLE BUCKINGHAM,[2] HARTFORD, CONN.

IN ORDER to understand and solve economically problems of manufacturing, it is necessary to keep in mind certain basic principles. Most of them are self-evident, yet it helps to have them stated definitely.

The accuracy to which we can work depends upon the accuracy with which we can measure. The mere removal of material from the part under construction is seldom difficult. The critical point is knowing when to stop. In large degree, the accuracy to which we do work depends upon the accuracy with which we measure.

However, if we are to produce parts of a prescribed accuracy, we must choose a suitable method of machining them as well as have proper measuring equipment. In addition, the machine on which the parts are produced and the tools used to shape them must be sufficiently accurate. Although all these other conditions must be met, the fact remains that the accuracy to which we can work depends upon the accuracy to which we can measure, because to produce the accurate machines and tools we must be able to detect the nature and amount of the inaccuracies in order to correct them.

In order to get the maximum of accuracy, only a single surface or a single dimension can be controlled by any one tool or other single element of the machine. Take for example the cutting of a thread. If a die is used, the three main elements—the form, the lead, and the diameter—are controlled by one tool. Adjustment for diameter is possible, but the form and lead are fixed. Variations are introduced in the form and lead when the tool is hardened. When one die replaces another, the variations are different. When no great degree of accuracy is needed, the use of dies is satisfactory. If the requirements are severe, this method of cutting threads is out of the question; the thread can be cut on a thread-milling machine or chased in a lathe.

There has been a marked tendency in the past few years toward the design of machines that can finish a given piece in one or two operations. For a large number of mechanical parts, where a high order of accuracy is not demanded, this has proved a success, but for the production of parts with exacting requirements these machines are not always suitable because frequent adjustments of the various tools are necessary to meet the requirements. When the machine is running, the production is high; but when one tool is being adjusted, all other tools on the machine are idle.

At present the limitations of multiple-operation machines are better appreciated and more attention is given to the single-purpose, single-operation machine tools. When these machines are automatic, with magazine feed, the labor cost of producing parts on such equipment is no greater than on multiple-operation machines, the tools are much simpler and cheaper, the production is as large, and the possible accuracy is much greater.

It is possible to build a machine to perform any repetitive operation. Furthermore, such work can always be done mechanically with greater accuracy than by hand. However, it is not always simpler to do it mechanically. But if large quantities are required, sooner or later mechanical methods are devised to produce them. Take for example the lapping of flat surfaces. Ordinarily this is done by hand, and a great deal of time, skill, and patience is required to obtain a flat surface. The mechanical lapping of such surfaces is a relatively simple matter. Furthermore these mechanically lapped surfaces can be made flat to within two or three millionths of an inch, an achievement almost impossible with hand lapping.

The fundamentals of precision manufacture may be summarized as follows:

1 The accuracy to which we can work depends upon the accuracy with which we can measure.
2 In order to realize the maximum of precision in production, each single element of a surface that is being machined must be controlled independently.
3 To obtain the maximum production with the maximum of precision, single-purpose, single-operation machines are better than multiple-operation machines.
4 A mechanical operation properly performed will give a higher degree of accuracy than any hand operation.

The past seventy-five years has witnessed a remarkable advance in all manufacturing industries. This has been due in part to the introduction and development of interchangeable manufacturing methods. These have been possible solely because of the development of precision manufacturing equipment; and the production of equipment of this type has been possible largely because of improved measuring facilities.

Interchangeable manufacturing and standardization go hand

(Continued on page 776)

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SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Refrigerating Machines with Air as the Agent

By MAURICE LEBLANC

A GENERAL consideration of the subject of refrigerating machines with air as the thermal medium, together with an analysis of the causes that make the ordinary air refrigerating machine inefficient, and a description of a new machine designed by the author.

Conception of the New Machine. If it were possible to cool or heat the air in a cylinder without letting it escape while the piston remained stationary at either end of its stroke, it would be possible to realize the ideal cycle by means of a single cylinder and a single piston such as shown in Fig. 1.

Referring to Fig. 2, it is seen that the specific volume of air comprised between the piston and the head of the cylinder varies from V_2 to V_3. Therefore in this machine the volume $V_3 - V_1$ would have to be produced per kg. of air to make ice instead of as in ordinary machines a volume $V_3 + V_4$, or one 4.62 times smaller.

The area τ_1 measures the apparent power consumed by the compressor and the area τ in Fig. 2 the useful power. We have then—

$$\tau = \int_{p_2}^{p_1} V dp - (P_1 - P_2)V_1 \ldots\ldots\ldots\ldots [1]$$

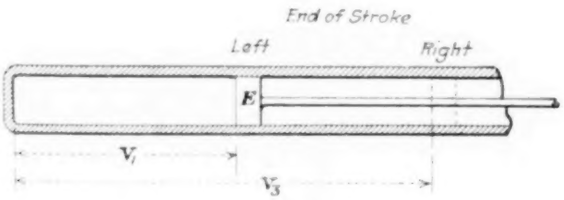


Fig. 1 Diagram of an Air Refrigerating Machine

On the other hand,

$$PV^k = P_2V_3^k \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

hence—

$$\tau_1 = \frac{k}{k-1} P_2V_3 \left[\left(\frac{P_1}{P_2}\right)^{\frac{k-1}{k}} 1\right] - (P_1 - P_2)V_1 \ldots\ldots [3]$$

and—

$$\tau = \frac{k}{k-1} P_2(V_3 - V_2) \left[\left(\frac{P_1}{P_2}\right)^{\frac{k-1}{k}} 1\right] \ldots\ldots\ldots [4]$$

If we make ice, we have—

$$V_2 = 1.448\, V_1;\ V_3 = 1.684\, V_2;\ P_2 = 0.5710\, P_1;\ \left(\frac{P_1}{P_2}\right)^{\frac{k-1}{k}} = 1.1770 \ldots [5]$$

from which—

$$\tau_1 = 0.15631 P_1V_1; \quad \tau = 0.068124 P_1V_1 \ldots\ldots\ldots [6]$$

The ratio $\frac{\tau_1}{\tau}$ is here only 2.29 instead of 16.39. It becomes therefore possible in an air refrigerating machine to attain a sufficiently high order of mechanical efficiency. On the other hand, each kilogram of air supplies $C_p(T_3 - T_2) = 7.6$ frigories. If it be assumed, as is usual, that the ambient medium absorbs 10 per cent, it will still be found that each kilogram of air supplies 6.84 useful frigories.

As the volume to be produced per kilogram of air is $V_3 - V_2 = 0.684 V_1$, the volume to be produced per useful frigorie is $0.1V_1$, and hence—

$$P_1V_1 = 29.272 T_1 = 8372 \text{ kg-m} \ldots\ldots\ldots\ldots [7]$$

An ammonia refrigerating machine must withstand an absolute pressure of 170,000 kg. per sq. m. (35,000 lb. per sq. ft.) if the condensing water delivered to it has a temperature of about 30 deg. cent. (86 deg. fahr.). If the same magnitude be assigned to the pressure P_1 in the above equation, we have $V_1 = 0.492$ cu. m. (17 cu. ft.). The volume that has to be produced per useful frigorie is therefore 4.92 liters.

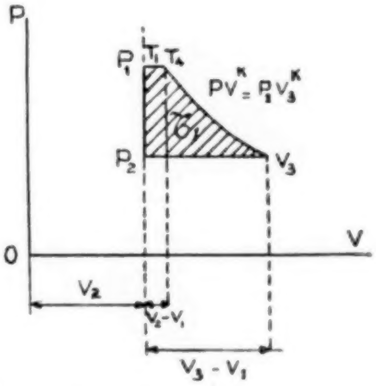


Fig. 2 Cycle Occurring in Machine Shown in Fig. 1

A good ammonia machine, single-cylinder, double-acting, 270 mm. (10.6 in.) bore with a stroke of 450 mm. (17.7 in.) running at 110 r.p.m. will produce in ice making 140,000 frigories per hour, and in doing so the piston will traverse a volume of 2.425 liters per frigorie, or about half of the above volume.

We might therefore build a geometrically similar machine the respective linear dimensions of which would be half of those just specified, and run it at twice the speed. The bore of the cylinder of such a machine would then be 135 mm. (5.2 in.), the stroke 225 mm. (8.85 in.), and the speed 225 r.p.m. The average piston speed and the velocity of flow of the fluid through the ports would be the same as in the larger ammonia machine, but the machine would be eight times lighter and consume four times less power, so that it would utilize the materials of which it was constructed twice as well.

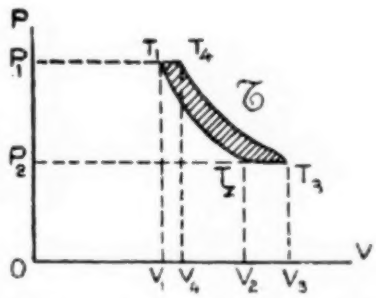


Fig. 3 Standard Cycle of Air Refrigerating Machine

With air as the refrigerating medium it is therefore possible to build a light and less bulky machine, provided small cylinders (a number of them if necessary) and high speed are employed, conditions which can be easily satisfied in an air machine but not in an ammonia machine, since in the latter case, in order to reduce the heat exchange between the ammonia and the walls, it becomes necessary to make the cylinders as large as possible, which is the reason why all of these machines are of the single-cylinder type and why their efficiency rapidly falls off with increase of capacity.

The automobile engine, which is really a hot-air engine, is equal in output to a large single-cylinder slow-speed gas engine, but while of equal output, it is enormously lighter and less cumbersome than the latter. The same applies to an air refrigerating machine.

Because of this, if we should succeed in building a machine in which the pistons would have to cover only a volume $V_3 - V_2$ per kilogram of air, there would be no trouble in making it as light and

as little bulky as an ammonia machine of the same output. We cannot expect, however, to heat or cool the air in the cylinders of a machine without removing it therefrom. This would lead us back from Watt to Newcomen, but we can produce an exchange of air from one cylinder with that from another cylinder hotter or colder than the first, leaving the piston stationary and scavenging the air by some kind of a blower which would only have charging losses just as in a two-stroke single-cylinder internal-combustion engine.

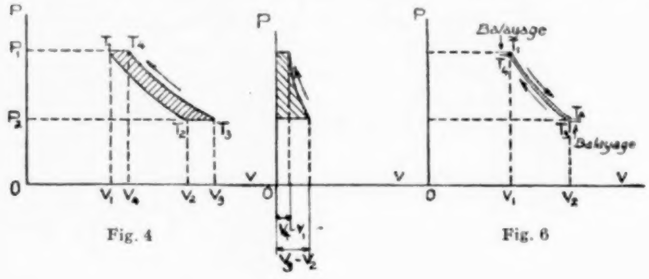


Fig. 4 Fig. 5 Fig. 6

FIGS. 4, 5, 6 VARIOUS CYCLES OF AIR REFRIGERATING MACHINE
(*Balayage* = scavenging.)

and the other compression, the two being infinitely close to one another. They represent the expansion curve of the cycle of Fig. 4. In this cycle the air taken in at the state $P_1V_1T_1$ is expanded and thereby brought to the state $P_2V_2T_2$. It is then through the scavenging process replaced by an equal volume of air having the state $P_2V_3T_3$. This latter is compressed and brought to the state $P_1V_4T_4$, and by a second scavenging process replaced by an equal volume of air at the initial state $P_1V_1T_1$. The work absorbed by the compression is equal to that delivered by the expansion and the area of the cycle is null. This can be obtained in practice by means of a special expander which the author calls a "Wattless" expander (*detendeur deWatté*), because it restores to the air all the work which the air furnished to it. Its apparent power consumption τ' is that of an ordinary compressor working with the cycle shown in Fig. 9 of the original paper, and we have, therefore,

$$\tau' = \int_{p_2}^{p_1} Vdp - (P_1 - P_2)V_1 \qquad [9]$$

provided—

$$PV^k = P_2V_2^k \qquad [10]$$

and hence—

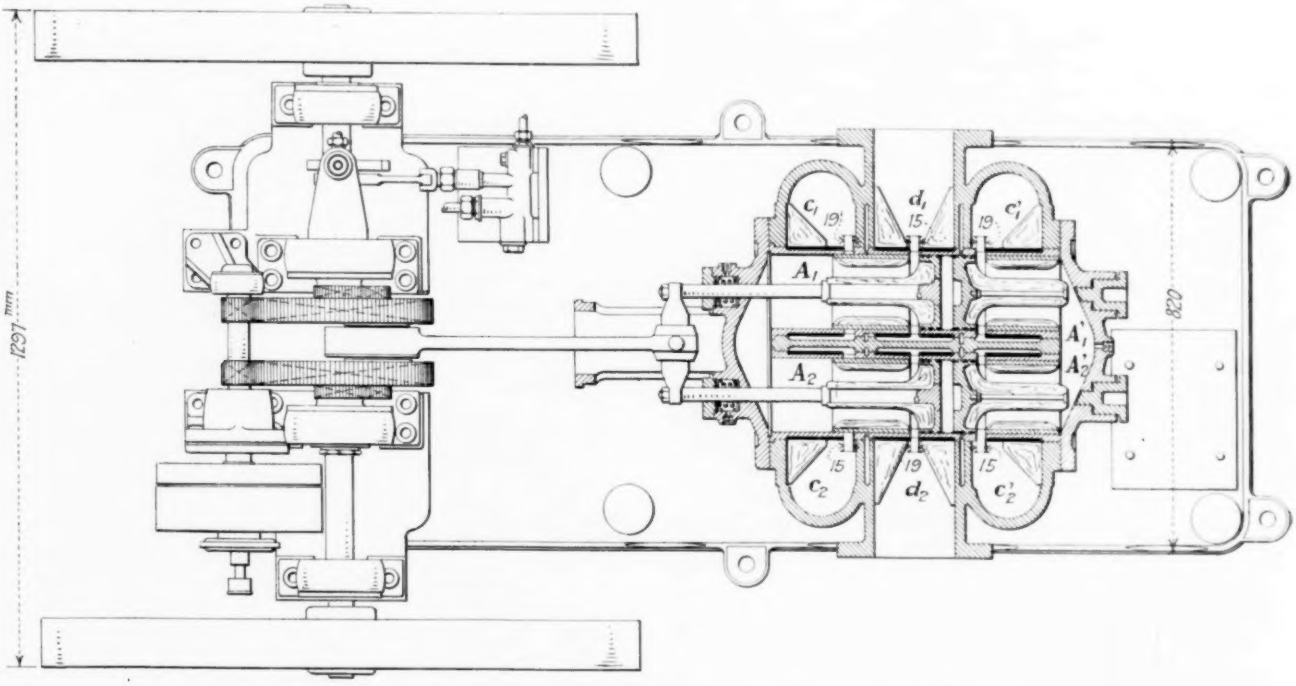


FIG. 7 "WATTLESS" COMPRESSOR OF THE LEBLANC REFRIGERATING MACHINE

The new machine is therefore fundamentally characterized by the following two features:

1 Its pistons in their travel cover only the volume $V_3 - V_2$ per kg. of air, and—

2 The exchange of air between the cylinders of the machine and its refrigerant and cooler is effected by scavenging means operated by blowers.

From this we may proceed to the consideration of the cycle of Fig. 3 reproduced in Fig. 4 as a superposition of the two cycles of Fig. 5 and Fig. 6. In the cycle shown in Fig. 5 the abscissa of the point of the compression curve having an ordinate P is equal to the difference of the abscissas of the points of the ordinates P of the compression curve, and the *expansion* of the first cycle. The area of the new cycle is equal to that of the old one, and the cycle is similar to the indicator diagram obtained on an ordinary compressor.

This cycle can be compared with that of a compressor provided with automatic poppet valves. The author calls it the "Watted" compressor (*compresseur Watté*), because all the work that it absorbs is given up to the air without any partial recuperation.

The cycle of Fig. 6 is composed of two curves—one expansion

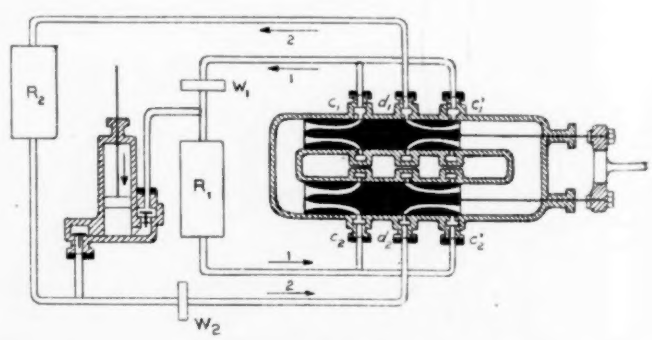


FIG. 8 DIAGRAMMATIC ARRANGEMENT OF ESSENTIAL ELEMENTS OF LEBLANC REFRIGERATING MACHINE

$$\tau' = -\frac{k}{k-1} P_2V_2 \left[\left(\frac{P_1}{P_2}\right)^{\frac{k-1}{k}} 1\right] - (P_1 - P_2)V_1 \qquad [11]$$

In ice making $\tau' = 0.08819P_1V_1$ kg-m. per kg. of air, while

the work τ_1 absorbed by the "Watted" compressor is equal to 0.068124 $P'V'$ kg-m. per kg. of air.

The apparent output of a "Wattless" expander is therefore 1.29 times the power of the "Watted" compressor.

The cycle of Fig. 4 could be realized by means of a single-cylinder machine furnished with poppet intake and exhaust valves and a special device for scavenging, but this would produce a supercharging effect and the air in the process of being scavenged would have to pass valves which it would be difficult to make of sufficiently large cross-section.

Fig. 7 represents a "Wattless" compressor built at the Havre shops of the Compagnie Electro-Mecanique. It consists of twin double-acting cylinders A_1, A_1' and A_2, A_2', arranged symmetrically with respect to the axis of the machine.

Each of the cylinders is provided with three ports (c_1, c_1' and d_1 in the first, c_2,c_2' and d_2 in the second), these ports being located all along the circumferences normal to the axes of the cylinders and the ports c_1,c_1' being located at the same distance from port d_1. These cylinders have identical pistons which move together, their rods being connected on the outside and driven from the same crankshaft. In each of these pistons there are two circular ports located along circumferences normal to the axis of the piston, so that their distance is equal to the distance of the ports c and d of the cylinders. Each one of these ports is in constant communication with the interior of the nearest cylinder by a passage through the interior of the piston. Finally, the cylinder ends A_1,A_2 are in communication with each other as well as A_1',A_2'.

Fig. 8 shows how this apparatus is connected to the cooler and the evaporator and also how the scavenger blowers and "Watted" compressor are arranged. This figure shows the pistons at the end of their stroke to the left. At that time the piston ports on the left are opposite the ports c_1 and c_2, and those on the right opposite d_1 and d_2. The ports c_1' and c_2' are closed by the walls of the pistons. Between the ports c_1 and c_2 there runs a circuit comprising the cooler R_1 and the blower W_1. The current of air produced by this latter enters the machine through port c_2 and leaves through port c_1. It drives out the air content between these ports and replaces it by the air coming from the cooler R_1 at the state $P_1V_1T_1$. Between the ports c_1' and c_2' there is another circuit comprising the evaporator R_2 and the blower W_2 [W_2 is not shown in the drawing in the original article and has been inserted by the abstractor. Editor.] The current of air produced by this latter enters the machine through port c_2' and leaves through c_1'. It forces out the air contained between these two ports and replaces it by air from the evaporator at the state $P_2V_3T_3$.

When the pistons move from their position at the left end of the stroke to the right they close first the ports c_1, c_2, d_1 and d_2. The air at the state $P_1V_1T_1$ contained in the cylinder heads at the left expands and arrives at the state $P_2V_2T_2$ when the pistons uncover the ports d_1, d_2, c_1', c_2', the ports c_1, c_2 still remaining covered. At the same time the air at the state $P_2V_3T_3$ contained in the cylinder heads to the right is compressed and thereby changed to the state $P_1V_4T_4$. By scavenging the air at the state $P_2V_2T_2$ is replaced by air at the state $P_1V_3T_3$, and air at the state $P_1V_4T_4$ by the air at the state $P_1V_1T_1$.

The "Wattless" expander causes a constant passage of air from the cooler to the evaporator, this air being then taken by the "Watted" compressor which draws it in at its exit from the evaporator R_2 in order to drive it into the cooler R_1.

The use of the "Wattless" compressor permits carrying out the scavenging only with ports of large section. As a rule the seat of the poppet valve of the compressor has a diameter one-third that of the cylinder and hence a section one-ninth as large, and even this is cumbered up at the guide so that at most only two-thirds of the cross-section may be utilized for the flow of air. In all, the useful section of a poppet valve is about 1/13.5 the cross-section of the cylinder.

While the ports in the LeBlanc machine cannot be made the full length of the circumference of the cylinder, they are nevertheless about three-fourths of that length, which gives quite a large space for the scavenging.

The machine shown diagrammatically in Fig. 8 consists of a "Watted" compressor, a "Wattless" expander, an evaporator, a cooler and two blowers. The machine working with saturated vapor would comprise only a "Watted" compressor, an evaporator and a cooler. Hence the cost of replacing saturated vapor by air is represented by the presence of a "Wattless" expander and two blowers. Since, however, it is possible to build the machines with smaller cylinders working at high speeds, the increase in machinery is not material. In addition to this the cost of construction of these machines is much smaller than that of ammonia machines, as less expensive materials can be used owing to the absence of corrosive action. Furthermore, while gas-tightness is as important here as in the case of ammonia machines, small leakages, if they should develop, would be devoid of danger, because of the non-toxic character of the medium employed.

The remainder of this very interesting article cannot be abstracted owing to the lack of space. (*Revue Universelle des Mines*, vol. 14, no. 3, Aug. 1, 1922, pp. 1–36, 16 figs., *tdA*)

Short Abstracts of the Month

AERONAUTICS

Experimental Research on Air Propellers, W. F. Durand and E. P. Lesley. National Advisory Committee reports Nos. 14, 30, and 64 comprise the results of a series of wind-tunnel tests on model forms of air propellers, extending over a three-year program of experimental work. These reports were made progressively and each without reference to the results given in preceding reports and relating to forms perhaps adjacent in geometrical form and proportion. These reports thus represent a survey, made in three parts, of a somewhat extended area covering a considerable number of model forms and proportions and varying in various characteristics in a systematic and regular manner.

At the conclusion of the work thus carried on in parts it has seemed desirable to review the entire series of results, to examine through graphical and other appropriate means the nature of the history of the characteristics of operation as related to the systematic variation in characteristics of form, proportions, etc., through the entire series of such variations; to check doubtful points of repetition of test; to remove inconsistencies where found, and generally to develop, for the series of models represented by these tests, a consistent set of results as judged by the relation of those for any one model of those for all models adjacent in geometrical form and proportion.

It is the purpose of the present report to give the results of this general analysis and review of these series of experimental observations. (Report no. 141 of *National Advisory Committee for Aeronautics*, 1922, 82 pp., numerous illustrations and tables, *eA*)

BUREAU OF STANDARDS (See Engineering Materials)

ENGINEERING MATERIALS (See also Metallurgy)

Effect of Temperature, Deformation and Rate of Loading on the Tensile Properties of Low-Carbon Steel below the Thermal Critical Range, H. G. French. An apparatus for determining tensile properties of metals at high temperatures (including limit of proportionality) is described in this paper in detail. Results of tensile tests at temperatures from 20 to 465 deg. cent. of various grades of $^1/_2$-in. boiler plate are also given, including (*a*) A.S.T.M. firebox steel; (*b*) marine boiler steel; and (*c*) railway firebox steel.

A section of the report is largely devoted to a discussion of the effects of different amounts of rolling at room temperature and at blue heat (300 deg. cent.) on the properties of such steels throughout the range given, and data are presented to show the effects of partial annealing, particularly at temperatures near the blue-heat range, on the cold and blue-rolled metal.

A series of experiments are described to show some effects of tensional elastic overstrain on the proportional limit, tensile strength and ductility of low-carbon steel at different temperatures, together with the subsequent behavior of the steel in both tension and compression upon aging.

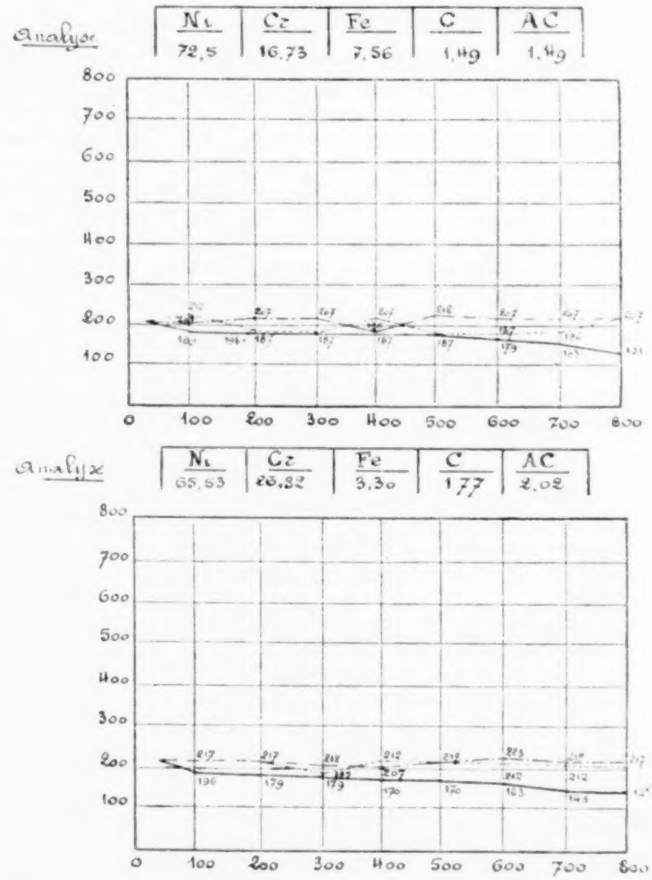
A modified form of the original apparatus is described whereby several rapidly moving dials indicating both stress and strain are simultaneously and repeatedly photographed by a motion-picture camera when rapid rates of loading are used.

Included also are results of tests showing the effects of both rapid and slow loading on the tensile properties of boiler plate at various temperatures.

In the general summary is given a brief discussion of the observed effects in the light of the amorphous-metal theory, and to illustrate typical fractures photomicrographs are included. (Abstract of *Technologic Paper no. 219 of the Bureau of Standards*, e)

High-Temperature-Resisting Alloys

TUBES FOR THE CLAUDE NITROGEN-FIXATION PROCESS, Leon Guillet. In the Claude ammonia process tubes or cylinders are submitted simultaneously to a temperature of 650 deg. cent. (1202 deg. fahr.) to a pressure of the order of 1000 atmos., and the action of hydrogen gas. The life of the tube, that is, its ability to resist the destruction wrought by these three factors, determines the commercial value of the process and has led to vigorous search after suitable materials.



FIGS. 1 AND 2 CURVES SHOWING THE VARIATION OF HARDNESS WITH TEMPERATURE OF HEAT-RESISTING ALLOYS
(Abscissas in deg. cent; ordinates in kg. per sq. mm.)

In this connection, the author mentions some of the work done at the Imphy Steel Works in France on chrome-nickel steels and also chrome-cobalt alloys.

Figs. 1 and 2 give curves determined since the war on the preservation of hardness by some of these new alloys at the higher temperatures—of interest because of the scarcity of information on the subject.

It would appear that steel containing around 13 per cent of chromium retains a good deal of its hardness up to about 600 deg. cent. (1112 deg. fahr.), but the A. T. G. metal developed by Chévenard at the Imphy Steel Works exceeds it in its ability to retain hardness at the higher temperatures. A remarkable feature about the A. T. G. metal is that in addition to large percentages of nickel and chromium it also contains a substantial amount of tungsten. The A. T. G. composition is said to have been definitely developed as early as the end of 1913.

Among other things, Chévenard developed an ingenious method for measuring the behavior of metals at the higher temperatures, which consists in registering on a photographic plate as a function of time the elongation of a wire carrying a given weight and maintained at a constant temperature. For a certain time an essentially constant velocity of elongation V is observed. In general, the curves $V = f(T)$ for different loads have a clearly apparent inflection, so that a temperature θ may be considered as separating the region of rigidity (practically speaking) from the region of viscosity. Everything else being equal, the border-line temperature θ is located higher for alloys of the A. T. G. type than for other alloys.

In the Claude process the metal of the tubes or cylinders has, however, to withstand not only the higher temperatures but also the action of gases. The author tested two tubes. One was made of ordinary steel with which Claude made his first experiment under a pressure of 1000 atmos. in 1907. This showed that the metal had been strongly attacked by hydrogen after 60 hours of operation at 550 deg.

The second tube was made of the Imphy metal. Because of improper operation it burst after 3300 hours of service. Unlike the common steel tube, it showed no decarburization due to the action of hydrogen. Apparently chrome and tungsten form carbides which are not attacked by hydrogen. In fact, the author suggests that it would have been comparatively easy to make a carbon-free alloy by using Mond nickel or electrolytic nickel and chromium prepared by the thermit process or specially refined. The percentage analysis of this second tube is given as carbon 0.44, nickel 60.40, chromium 8.70, tungsten 2.52, manganese 1.80, iron 24.73, or a total of 98.59 per cent, the nature of the remainder of 1.41 per cent not being indicated.

In this connection it may be of interest to point out that nichrome, according to a paper by A. Bensel before the American Society for Steel Treating (abstracted in MECHANICAL ENGINEERING, vol. 43, no. 9, Sept., 1921, p. 612), contains nickel, 60 per cent; chromium, 12 per cent; iron 26 per cent; and carbon, silicon, manganese, etc., 2 per cent. (*Memoires de la Société des Ingénieurs Civils de France*, vol. 75, series 8, nos. 4–5–6, April to June, 1922, pp. 320–325, 4 figs., *deA*)

Corrosion of Steel—Copper Steels

THE CORROSION OF IRON AND STEEL, Sir. Robert Hadfield, Hon. Mem. Am.Soc.M.E. This paper refers to the wastage of the world's iron and steel due to corrosion and describes a number of experiments recently carried out by the author with regard to copper steel.

Careful estimates, it is stated in the paper, appear to show that there is a present annual loss of over 40,000,000 tons of iron and steel under corrosion, together with the consequent removal of material rendered unserviceable.

The author's research was conducted on fourteen types of various materials—in all, 1330 specimens.

As regards the resistance to corrosion of steel containing copper, the author refers to work of American investigators, in particular, B. M. Buck, and to experiments by Prof. O. Bauer of Berlin. From his own tests he draws the following conclusions.

1 *Atmospheric Corrosion.* Copper steel is rather less corroded than ordinary steel, but especially so in the more corrosive industrial atmosphere at Attercliffe. This applies to both material with rolling scale on and with the same removed. Material with the scale removed is more resistant than with the scale on, confirming what is generally found to be the case.

2 *Sea Water.* Ordinary steel corrodes the more rapidly at first; subsequently the rate of corrosion for both materials slows up, indicating a certain degree of "self-protective" action, which is rather more pronounced for ordinary steel. At the end of 16 weeks, however, the total extent of the corrosion of copper steel is still less than that of ordinary steel. The relative behavior of the material with scale on and that with the scale removed is the same as for atmospheric corrosion.

3 *Tap Water.* There is little to choose between the two mate-

rials, which maintain a fairly constant rate of corrosion over nearly four months. The tap water, which initially is not so corrosive as sea water, over the longer period is more corrosive, due to the absence of self-protective action of the steels against this medium. In this case no specimens were tested with their rolling scale on.

4 *Fifty Per Cent Sulphuric Acid.* With original scale on, both materials are attacked very rapidly at first; while, however, the rate is maintained when reimmersed after a three weeks' exposure and weighing, the steel containing copper is only very slowly attacked. During the three months' period of the second immersion the rate is only about one-sixteenth of the rate during the first period of three weeks. Apparently, therefore, when the scale has become detached and the attack takes place more directly on the surface of the steel, the steel containing copper is very resistant to a 50 per cent solution of sulphuric acid. That this is so was confirmed by a seven days' test on a freshly prepared and polished specimen free from scale.

5 *Twenty Per Cent Sulphuric Acid.* A seven days' test on specimens with the scale removed, while showing more vigorous action than the 50 per cent solution, confirms the great superiority of the steel containing copper against attack by sulphuric acid.

In the author's tests, therefore, the conclusions arrived at, both from the American and the German tests, as to the superior resistance of mild steel containing a small percentage of copper to atmospheric corrosion, are borne out—not, however, to the extent shown by the American tests. The superiority amounts to about 10 per cent in pure air, increasing to about 25 per cent in an industrial atmosphere. As in the German tests, the results of immersion in sulphuric acid point strongly to the amount of sulphurous impurity carried by the air.

The author's tests, so far as immersion in ordinary water is concerned, confirm Dr. Cushman's opinions and also the German conclusions: that is, no advantage for the copper steel is to be looked for in this direction. In sea water the above tests indicate, at any rate for a comparatively short period of exposure (a few months), a certain superiority for the copper steel. With a very long period of exposure, however, it is possible this superiority may be wiped out or even negatived, and in this respect again they bear out Dr. Cushman and the German conclusions. The excellent results obtained in America for the copper steels are, to a certain extent, ascribed by the author to the superior physical conditions of the steel as compared with the ordinary mild steel.

Microscopic examination of the materials shows a difference in structure between the copper steel and ordinary mild steel. While both materials show the usual character of mild steel, i.e., mainly ferrite grains with carbon distributed in the form of carbide of iron, the carbide in the case of the steel containing copper is invariably confined to the grain junction; in the mild steel the carbide is indiscriminately distributed throughout the material.

The author includes a few words of caution in regard to forming general conclusions as to whether a small percentage of copper as a constituent of steel is really desirable for general service conditions. He claims that a small copper content, say, 0.16 to 0.25 per cent, is beneficial, provided the condition is that of *bare* metal exposed to atmospheric corrosion, especially in a sulphurous atmosphere, but no recorded tests have yet shown that *coated* metal would be benefited by a copper content.

Unquestionably, in the majority of service conditions, iron or steel is subjected to either total or partial immersion in natural waters, or some sort of liquid phase. It is by no means certain that, under such conditions, a copper content in steel might not actually be deleterious, and it is fair to state that this opinion is held very strongly by Dr. Cushman and other investigators who have been long studying these problems. The study is exceedingly difficult, owing to the fact that a given type of iron or steel, which may behave very well under one set of conditions, will quite reverse its behavior under another set. It is necessary, therefore, to proceed with extreme care before drawing important conclusions on the basis of any tests so far carried out, which might be the means of inducing steel manufacturers generally to introduce copper as a commercial constituent of mild steels.

It should be noted that if such a practice came into general use, the scrap of the steel-manufacturing countries would become greatly infected with copper, which is not thereafter removable by the various refining processes now employed. If future experience should tend to show that a copper content was in many cases deleterious rather than beneficial, this would be a most serious and important consideration. (*Proceedings of the Royal Society*, Series A, vol. 101, no. A 713, Sept. 1, 1922, pp. 472–486, *egA*)

FOUNDRY

Melting Steel and Cast Iron Together in the Cupola, J. Hogg. In the plant with which the author was connected the charge was made up of foundry scrap (runner heads, risers and gates), pig iron of proper brands, and semi-steel, in particular turnings.

After a few days of running it was found that the metal was too hard, which was obviously due to the fact that foundry scrap from semi-steel melting contained a higher percentage of low-carbon material than similar scrap from pure gray-iron operation. It was necessary, therefore, to reduce the steel added to the charge for a few days, by which softer metal was obtained without affecting the density or the tensile result.

The writer often used steel in amounts of 15 per cent and it is fairly satisfactory, provided the metal is poured hot. In general, a fall of temperature at pouring is favored, because of the danger of hard spots. If the metal is at all "dull," blowholes are almost certain to appear in machining.

A simple hardness test is used. A small sample of the iron is polished and then boiled for a few moments in sodium picrate.

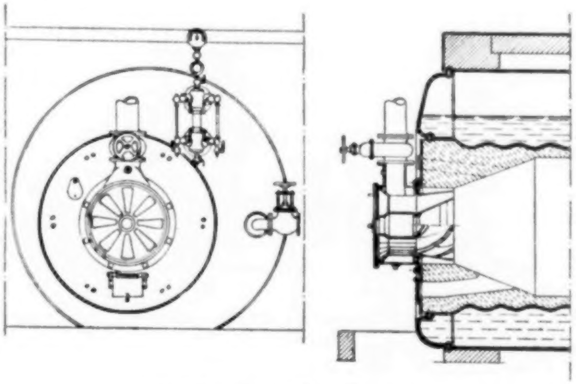


Fig. 3 Muller Gas Burner

The combined carbon will assume a rich brown color, and its amount from day to day can be easily judged. This may be used as a special test for hardness and can be carried out by means of a low-power microscope.

The author does not recommend the addition of steel to the metal in the ladles because it lowers the temperature of the metal in the ladle, which is vitally undesirable. (Paper before the Lancashire Branch of the Institution of British Foundrymen, abstracted through *The Foundry Trade Journal*, vol. 26, no. 314, Aug. 24, 1922, pp. 160–161, *p*)

FUELS AND FIRING

Gas Burner for Blast-Furnace Stoves or Boilers

Muller Gas Burner, A. Thau. Description of the Muller gas burner, the particular feature of which (Fig. 3) is that by means of a number of fixed, peculiarly twisted blades, the gas entering the burner is forced into a rotating corkscrew motion on its way to combustion. The front portion of the burner is divided by the blades into a number of radially distributed compartments alternately conveying gas and serving as air inlets. The peculiar twist of the blades is such, however, that the screwlike partitions have different pitches for gas and air, so that the free available area is differently proportioned in accordance with the heating value of the gas.

The burner differs from the majority of similar apparatus, in that no attempt is made to force the gas and air into an intimate mixture inside the burner body, and upon leaving the burner mouth the gas and air are divided into a number of fine streams distributed over the periphery in proper rotation.

The way in which gas and air leave this burner and enter, for instance, a boiler tube can best be explained by comparing it with rope making. As in rope making, the single yarns are issued over a distributing ring, and in the case of a thick rope keep turning around all the time, so there shoot from this burner thin streams of air and gas through the annular burner mouth that form inside the boiler tube a large hollow rotating column resembling a hollow rope. It is very interesting to observe this rotating combustion by throwing a small, fairly hard-pressed ball of paper into the burner, whereupon its spiral passage through the whole length of the tube can be plainly observed. To attain such a way of combustion was a step forward, since with most other burners in which the flame burns simply on a horizontal axis within the tubes, an intimate contact by means of which every single spot of the inner tube plate is covered by the flame cannot be attained without a great excess of heat and consequent waste. Data of performance of the burner are given in the original article and it is stated that the burner properly designed may be applied either to blast-furnace stoves or boilers, such as Lancashire or Cornish.

Since 1919 over 300 burners of this type have been installed for various purposes (the author refers apparently to Swedish practice) and have shown their ability to handle severe fluctuations of gas pressure. (*Blast Furnace and Steel Plant*, vol. 10, no. 9, Sept., 1922, pp. 470–472, 1 fig., *d*)

GAS PRODUCERS

Stassano Electric Gas Producer

STASSANO ELECTRIC GAS PRODUCER, Dr. of Eng. Gwosdz. Considerable interest has been directed recently toward the development of an electrically operated gas producer, particularly in countries where water power is ample and coal expensive, e. g., in the Scandinavian countries and Italy. There the idea arose that it might be worth while to gasify coal by electrically generated heat. In view of the comparative scarcity of information on this development, the following description of the (Italian) Stassano electric gas producer may be of interest.

Fig. 4 shows a design which is said to be in actual operation. The combustion chamber designed to take 400 kw. consists essentially of a cylindrical iron jacket ending at the bottom in a water seal and having on the top a cover equipped with the usual charging hopper with double doors. The shaft has a grate at the bottom and is lined the entire height with fire-brick.

At three different heights in the shaft there appear sets, three in each, of equally spaced electrodes passing through the shaft wall and directed toward the vertical axis of the shaft. The electrodes project part way into the chamber. At the places where they pass through the wall, water cooling is provided and the electrodes are of course electrically insulated from the wall.

A little above the lower set of electrodes there are provided in the wall a number of comparatively small openings through which porcelain tubes are inserted. These tubes serve for admitting steam or air. In addition to these openings a number of peep holes are provided to permit inspection of the fire.

The three groups of electrodes are connected in parallel to the generating circuit. The gas-outlet pipe is set directly under the top cover.

To start the producer a layer of fuel in not too large lumps is placed over the grate. When this layer is heated up more fuel is gradually added until the coal in the shaft reaches up to the level of the topmost series of electrodes. When at that time, the current is cut in it flows immediately through the entire column of coal in the furnace, forming small arcs in jumping from one piece of coal to another, and these numerous arcs generate and gradually increase the heat until the entire fuel bed reaches a very high temperature. The time necessary for this depends on the available electrical energy and the amount of coal in the furnace.

Means are provided for shaking the fuel bed and thereby assisting in the uniform heating of the coal.

If now means for the gasification of the fuel, such as air or steam, be admitted through the porcelain tubes referred to above, the same chemical processes take place as in an ordinary gas producer, the oxygen of the air and steam being converted into carbon monoxide, while the hydrogen from the decomposition of steam is set free. Therefore, by proper manipulation the producer can be made to deliver either producer gas or water gas.

Under certain conditions, the most vital of which is low price of electrical energy, electrical gasification presents considerable advantages, especially for operating industrial furnaces requiring very high temperatures. These advantages consist in a material saving in fuel per unit of gas produced, which is said to amount to one-half in Stassano producers making water gas from coke. Furthermore, this process makes it possible to obtain regularly a water gas of high heating value. (*Motor und Auto*, vol. 19, no. 15, Aug. 31, 1922, pp. 205–207, 1 fig., *d*. Based on an article by Ernesto Stassano, *Il Gasogeno termo-elettrico* in *La Metallurgia Italiana*, Dec. 31, 1922(?), pp. 575–623)

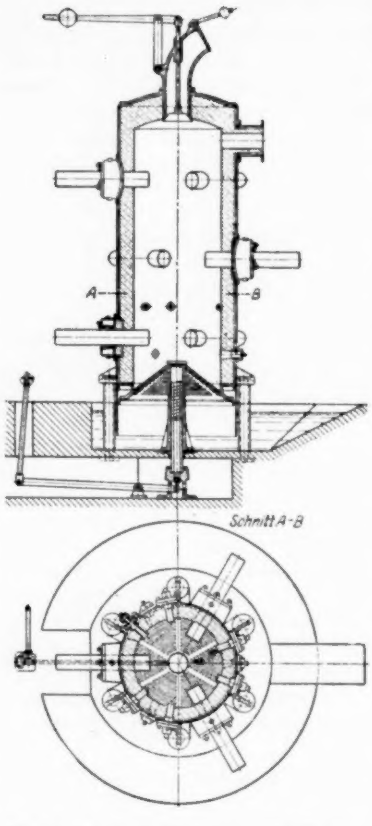


FIG. 4 STASSANO ELECTRICALLY HEATED GAS PRODUCER

HYDRAULIC ENGINEERING (See Mechanics)

INTERNAL-COMBUSTION ENGINEERING (See also Machine Parts, Marine Engineering)

TELLURIUM AS AN ANTI-KNOCK COMPOUND, H. A. Doerner. In discussing the properties and possible uses of tellurium the author states that the use of $^2/_{10}$ of 1 per cent of diethyl telluride in gasoline as an anti-knock compound has been reliably reported. It is said to eliminate carbon deposits and to produce greatly increased efficiency when used in motors designed to operate on very high compression. A special type of engine is said to be required to produce these results, hence its general use in motors will not be feasible unless the motor industry should conform to the required type. This step in turn would be dependent on a supply of tellurium adequate to treat all the motor fuel. For this purpose 1500 tons of tellurium per year would be required, and as the possible annual supply of tellurium from the present best-known sources—copper refineries—is said to be only about 125,000 lb., a much larger supply must be developed; the discovery of new uses not dependent on so large a supply would result in wider utilization of present resources. (*Reports of Investigations of the Bureau of Mines*, Serial no. 2385, Aug., 1922, 3 pp., *g*)

MACHINE PARTS

PISTON RINGS, John Magee. All piston-ring manufacturers prefer to make rings with the finished surfaces ground to size. It is easier to hold accurate dimensions on a grinding machine than it is on a lathe. However, hard castings and hard spots in castings are machined without difficulty or detection by grinding. For this reason piston rings with a *turned* finish on the diameter dimension should be specified. Neither the scleroscope nor the Brinell hardness test will disclose hard spots in castings. A ground finish may cover up many hard spots or a hard scale. The production of a turned surface is a somewhat slower process for the manufacturer, but it guarantees a uniform soft wearing surface.

Flatness is very essential, since a serpentine condition will allow leakage around the back of the ring through the ring groove. If all

of the internal stresses are not removed during the process of machining, the ring is apt to warp sidewise. Therefore width dimensions should be inspected with a light gage instead of with a micrometer. With a ring lying on a perfectly flat surface, a side warp will cause it to register oversize. With measurements at intervals the two points of a micrometer might indicate a parallel width on a ring considerably warped.

The most common "defect" in the manufacture of piston rings is the elliptical ring, generally termed "out-of-round;" tolerance may vary according to the amount that the ring is likely to be worn in on the block. At best it is desirable to keep the variation within very low limits, say, 0.00025 in. to 0.00050 in. If the tolerance is expressed in light-gage terms, it is much more simple for inspection, because the light gage is at present the most practical inspection device for locating out-of-round rings.

No accurate data are available for determining the poundage or wall pressure of piston rings to accomplish definite purposes. Actual experiments conducted at different times for different purposes seem to indicate that a poundage in excess of 4 lb. per sq. in. of bearing surface is needed to prevent collapse under pressure. Therefore a poundage of 5 lb. per sq. in. has commonly been specified for all purposes.

There seems to be a diversity of opinion as to the proper gas opening or expansion allowance. This is probably due to the difference in the estimated temperatures to which a piston ring is subjected. Using 0.0000056 per in. per deg. as the coefficient of expansion of cast iron, a minimum opening allowance for maximum expansion is obtained by multiplying this coefficient by the circumference of the ring. (*The Journal of the Society of Automotive Engineers*, vol. 11, no. 3, Sept., 1922, pp. 273–274, *p*)

Worm-Gear-Type Speed-Reduction Trains

Reduction and Change-Speed Gear. Description of a form of speed-reducing and change-gear mechanism recently introduced by an English concern. The outstanding feature of the system is the exclusive use of worms and worm wheels instead of the usual spur wheels.

From Fig. 5 it appears that the two shafts *A* and *B* are mounted transversely to the driving and driven shafts *C* and *D*, which are coaxial. Driving connection is established by the worm *E* and worm wheel *F*, the worm gear *G* gearing with the worm on the driving shaft *C*, and worm *H* engaging a worm wheel on the driven shaft *D*.

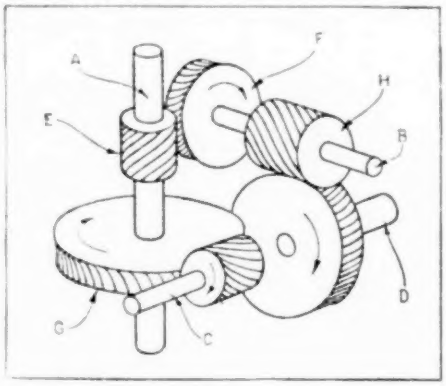


Fig. 5 H. R. Reduction and Change-Speed Gear, General Diagram

In this example a reduction to the third power is obtained, i.e., once for each three sets of worms and worm wheels employed. It is claimed that with the simple gear it is possible to obtain a ratio as high as 100,000 to 1, while by the introduction of two additional elements the gears can be compounded to give a speed ratio of 10,000,000 to 1.

The same principle may be readily adapted for speed changing in that by the addition of one unit a three-speed gear is obtained. If required, the driven shaft can be made to rotate in the same direction as the driving shaft at all speeds.

Fig. 6 shows an arrangement being a 100 to 1 reduction gear for a 1/2-hp. drive at 750 r.p.m. Another illustration in the original article shows a 30,000 to 1 reduction for driving a conveyor plant arranged for a 1/2-hp. drive at 960 r.p.m. The speed of the final shaft is 1.92 revolutions per hour, and some idea of the power transmitted may be gathered from the fact that the torque on this shaft is approximately 400,000 to 500,000 in-lb.

It is claimed that an efficiency of from 80 to 90 per cent is obtained

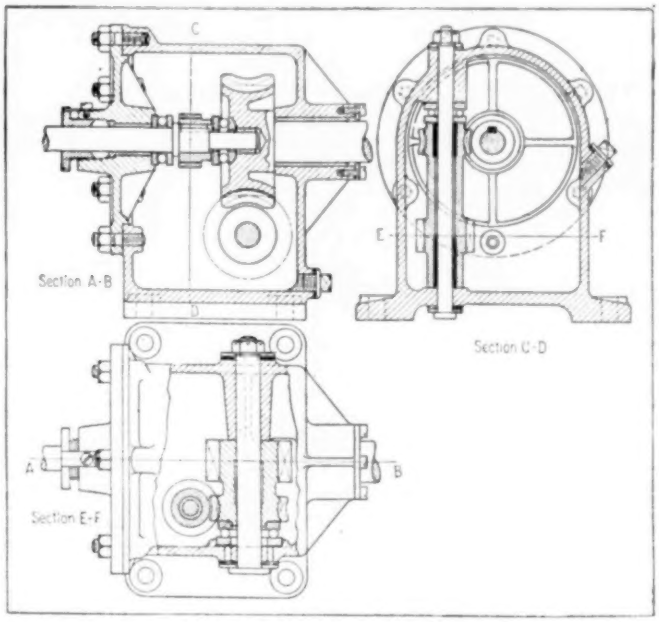


Fig. 6 H. R. 100 to 1 Reduction Gear

on gearing having ratios up to 250 to 1. (*Engineering Production*, vol. 5, no. 101, Sept. 7, 1922, p. 224, 3 figs., *d*)

MARINE ENGINEERING

Prospects of the Marine Diesel Engine

The Propelling Machinery of the Cargo Carrier of the Future, James Richardson. The shipping industry of the seagoing nations of the world is now faced with the necessity of increasing tonnage, notwithstanding the fact that the total tonnage today available is generally in excess, certain classes being excepted, of the freight-carrying demands. The author is therefore looking forward to the building of a considerable amount of new tonnage in the near future.

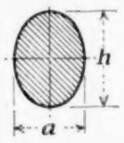
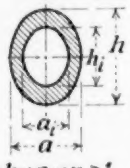
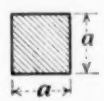
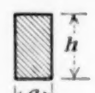
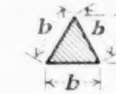
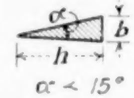
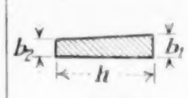
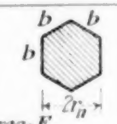
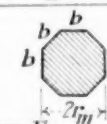
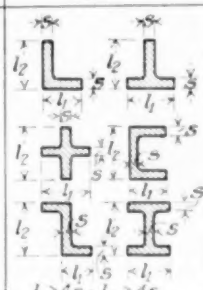
For fast passenger traffic, such as liners in the transatlantic service, the problem appears to have been solved for the time being by the use of steam generated on oil fuel. For the average cargo carrier the burning of fuel oil under boilers with the present prices ruling for coal and oil is uneconomical. On the other hand, oil has considerable advantages as a fuel, and, all conditions considered, the Diesel oil engine as the most economical consumer of liquid fuel makes a most compelling appeal.

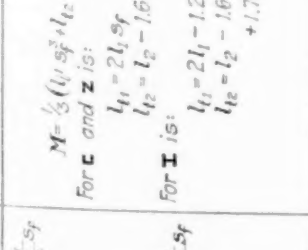
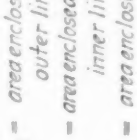
The present position of the Diesel engine is gradually but surely strengthening. There are now available more types of marine propelling plants of all kinds, and particularly of Diesel engines, than ever previously, and the Diesel engine has recently received indirect advantage from the troubles which have been experienced with double-reduction gearing.

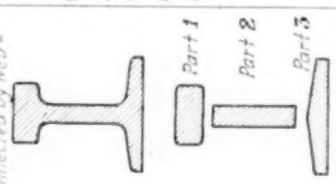
The maximum powers for which the Diesel engine can definitely be stated to be suitable are today 300 b.hp. per cylinder and 16 cylinders; i.e., two engines, each of eight cylinders, a total of 4800 b.hp. or the equivalent of 5500 steam i.hp. total, is the standard for the larger class of motor vessels. However, the time is not far distant when Diesel engines of 400 to 500 b.hp. per cylinder will be operating at sea with success.

The Diesel engine still remains a massive and somewhat complicated power plant, and no movement toward simplification has yet definitely set in. Undoubtedly, when ship owners and their superintendents have come to appreciate the principles of operation of this prime mover, a number of so-called "gadgets" at present introduced as safeguards and in order to make assurance doubly sure, will be discarded. Only in this way does it seem possible definitely to attain greater simplicity. As regards reducing the mass of the engine, there are only two ways in which this can be achieved: either by increasing the mean effective pressure in the cylinders or the piston speed. The governing factor in the design of all internal-combustion engines is the heat-flow factor. The greater the cylinder

TABLE 1 TORSIONAL STRENGTH OF BARS (See page 740)

NO.	CROSS-SECTION	MOMENT	STRESSES
1		$M = \frac{\pi}{2} r_a^4 \, G\vartheta$	At points on circumference: $\tau_{max} = r_a \, G\vartheta$ At distance r from center: $\tau = r \, G\vartheta$
2		$M = \frac{\pi}{2}(r_a^4 - r_i^4)\, G\vartheta$	At points on outside circumference: $\tau_{max} = r_a \, G\vartheta$ At distance r from center: $\tau = r \, G\vartheta$
3	 $h : a = n > 1$	$M = \frac{\pi}{16} \frac{n^3}{n^2+1} a^4 \, G\vartheta$	At terminal points of the minor axis a: $\tau_{max} = \frac{n^2}{n^2+1} a \, G\vartheta$ At terminal points of the major axis h: $\tau = \frac{1}{n} \tau_{max}$
4	 $h : a = h_i : a_i = n > 1$	$M = \frac{\pi}{16} \frac{n^3}{n^2+1} (a^4 - a_i^4)\, G\vartheta$	At terminal points of the minor axis a: $\tau_{max} = \frac{n^2}{n^2+1} a \, G\vartheta$ At terminal points of the major axis h: $\tau = \frac{1}{n} \tau_{max}$
5		$M = 0.1404 \, a^4 \, G\vartheta$	In middle of sides: $\tau_{max} = 0.6753 \, a \, G\vartheta$ At the ends of the sides the stress is nil
6	 $h : a = n > 1$	$M = n \psi_3 a^4 G\vartheta$ where $n\psi_3 \sim \frac{1}{3}\left(n - 0.630 + \frac{0.052}{n^4}\right)$	In the middle of the long sides: $\tau_{max} = \psi_1 \, a \, G\vartheta$ where $\psi_1 \sim 1 - \frac{0.65}{1+n^3}$ At the corners $\tau = 0$
7	 $h : a = n > 4$	$M \sim \frac{1}{3}(a^3 h - 0.630 a^4)\, G\vartheta$	At points of the long sides with the exception of the ends: $\tau = \tau_{max} \sim a \, G\vartheta$ In the middle of the short sides: $\tau = 0.7425 \, b \, G\vartheta$ At the corners $\tau = 0$
8		$M = \frac{h^4}{15\sqrt{3}} \, G\vartheta = \frac{b^4}{46.188} \, G\vartheta$	In the middle of the sides: $\tau_{max} = \frac{h}{2} G\vartheta = \frac{b}{2.309} G\vartheta$ At the corners: $\tau = 0$
9	 $\alpha < 15°$	$M \sim \frac{1}{12} h b^3 - 0.105 b^4$	At points on the long sides near the base line: $\tau_{max} \sim b \, G\vartheta$ At the corners $\tau = 0$
10	 $h = 4 b_1$	$M \sim \frac{1}{12} \frac{h(b_1^4 - b_2^4)}{b_1 - b_2} - 0.105(b_1^4 + b_2^4)$	At points on the long sides near the wider base line b_1: $\tau_{max} \sim b_1 \, G\vartheta$ At the corners $\tau = 0$
11		$M \sim \frac{1}{12} \frac{h(s_1^4 - s_2^4)}{s_1 - s_2} - 0.210 s_2^4$	In the middle of the long sides $\tau_{max} \sim s_1 \, G\vartheta$
12	 Area $= F_a$	$M = 0.533 r_m^2 \, F_a \, G\vartheta$	$\tau_{max} = 1.223 \, r_m \, G\vartheta$
13	 Area $= F_a$	$M = 0.520 \, r_m^2 \, F_a \, G\vartheta$	$\tau_{max} = 1.164 \, r_m \, G\vartheta$
14	Bent strip of constant width 	$M = \frac{1}{3}(l b^3 - 0.63 b^4)\, G\vartheta$	At the points on the long sides with the exception of ends the stress is: $\tau \sim b \, G\vartheta$ On the concave side the stress is somewhat larger and on the convex side somewhat smaller.
15	 $l_1 > 4s$; $l_2 > 4s$ Radii of Fillets = s	$M = \frac{1}{3} l_t \, s^3 \, G\vartheta$ For L: $l_t = l_1 + l_2 - 1.6 \, s$; For ⊥: $l_t = l_1 + l_2 - 0.9 \, s$; For +: $l_t = l_1 + l_2 - 0.15 s$. For ⊏ and Z: $l_t = 2 l_1 + l_2 - 2.6 s$; For I: $l_t = 2 l_1 + l_2 - 1.2 s$	At points on the border line with the exception of the ends $\tau \sim s \, G\vartheta$ At the Fillets τ is about 16 Per Cent higher

NO.	CROSS-SECTION	MOMENT	STRESSES
16		$M = \frac{1}{3}(l_1 s_f^3 + l_{t2} s_s^3) G\vartheta$ For ⊏ and Z is: $l_{t1} = 2l_1 s_f$ $l_{t2} = l_2 - 1.6 s_f$ For I is: $l_{t1} = 2l_1 - 1.26 s_f$ $l_{t2} = l_2 - 1.67 s_f + 1.76 s_f$	$\tau_{max} \sim s_f G\vartheta$ along the sides of the flange. At points on sides of the web: $\tau \sim s_s G\vartheta$ At points on the fillets the stress is slightly higher.
17	Any Ring of Constant Width 	$M \sim 2(F_a + F_i) \frac{F_m s}{U_m} G\vartheta$ F_a = area enclosed by the outer lines F_i = area enclosed by the inner lines F_m = area enclosed by the intermediate ring lines U_m = length of the intermediate ring lines s = width of ring	The average value of the stress in the ring: $\tau_a = 2G\vartheta \frac{F_m}{U_m}$

NO.	CROSS-SECTION	MOMENT	STRESSES
18	Section with a small semi-circular notch 	The moment is equal to the moment of an unnotched cross-section	At point P_1 there is a local increase of stresses to about twice that in the unnotched cross-section.
19	Section with a small angular notch 	The moment is equal to the moment of an unnotched cross-section	At point P_1 the local stress up to the value $\tau = \infty$
20	Composite cross-section of two sections connected by web – 	The moments M_1, M_2, etc. for the various separate parts have to be found as functions of the values of their cross-sections and of $G\vartheta$. For the total cross-section, $M \sim M_1 + M_2 + M_3$, etc.	The stresses in the individual parts have to be computed as functions of the value of cross-section and $G\vartheta$. For the composite cross-section the stresses are the sum of those of the parts, with the exception of slight variations at the junctions

dimensions, the more vital is this consideration. This factor, expressed in pounds of fuel consumed per square inch of combustion-volume surface per unit of time, is directly dependent upon the piston speed; and for a constant factor of heat flow, the lower the piston speed, the higher the mean effective pressure possible. The converse is equally true.

The tendency for some years past has been to reduce this heat-flow factor with increasing size, but the gradual improvements in materials and designs which have permitted of increasing size, as already stated, now allow augmented heat flow by increasing the mean effective pressure in the cylinders and the piston speed.

The piston speed with a single-acting internal-combustion engine can well be considerably higher than with steam practice because of two considerations: firstly, because the maximum pressure for which bearing surfaces are designed is only maintained for approximately $12^1/_2$ per cent in the case of four-stroke engines and 25 per cent of the cycle for two-stroke engines; and secondly, because the pressures on the bearing and guide surfaces are not reversed as with double-acting steam engines. The inclination, therefore, especially with four-cycle machinery is to increase piston speed. With twin-screw ships of relatively high speed, revolutions higher than is usual with steam machinery can be adopted without impairing to any serious extent the overall propulsive efficiency. With single-screw vessels, especially those of low speed, the propeller speed must be kept low, and long-stroke engines will increasingly be adopted to attain a high piston speed and good propeller efficiency.

One point that is not perhaps sufficiently emphasized, is that with Diesel machinery, the higher the power per cylinder, the greater the weight per horsepower, so that for a given power of ship there is a definite saving in machinery weights when twin-screw engines are adopted in comparison with single-screw machinery. This saving in weight means a certain reduction in cost, although the lesser machinery cost is balanced by the increased cost of hull, due to the extra bossing of the stern and the two tunnels for the two lines of shafting. The chief advantage of single-screw machinery lies in the reduction in personnel which is possible, as obviously an increased engine-room complement is required to superintend and to maneuver two engines. Nevertheless, for powers above 2000 to 3000 shaft hp. twin-screw Diesel engines will be the rule for some time to come and are to be advocated.

The saving in fuel costs with Diesel machinery must be considered in conjunction with the lubricating-oil consumption, which is higher than with steam machinery. At first this subject was not perhaps fully appreciated, but today it can confidently be stated that with the latest internal-combustion machinery the problems associated with the necessary lubrication of the piston rings and the forced feed to the main bearings have been most conscientiously attacked, and the consumption of lubricating oil has been reduced to a figure of relatively small importance. One and one-half gallons of lubricating oil for all purposes per ton of fuel oil consumed should be the relation, and has been attained.

As regards personnel which also affects upkeep, it is stated that there is available an increasing number of engineers conversant with the first principles of internal-combustion engines, among others those from the ranks of engineers of engine-building concerns.

As regards auxiliary services, Diesel-engined ships can employ electric drive economically and effectively. The author therefore comes to the conclusion that the motorship has arrived today at the position where the ship owner has few remaining doubts as to the capacity of the oil engine. The factors of cost are still acting as deterrents to some extent, but when next marine construction is energetically pursued, the motorship will be in the far front if Great Britain is to maintain its supreme position as a sea going and trading nation. Today at sea the tonnage of motor ships is 6.5 times what it amounted to in 1914, and of the present total more than one-half represents 149 vessels of over 3000 tons. (Paper read before Section G of the British Association at Hull, Sept. 12, 1922, abstracted from advance proof by special courtesy from *Engineering*.)

MECHANICS

Stresses Due to Gravity in Pipe Lines of Large Diameter and Their Rational Construction, Karl R. Carlsson. The author claims that notwithstanding the great importance of proper design in pipe lines of large diameter in connection with hydraulic installations—because of their great cost and the necessity of maintaining them in reliable operation—exact methods of calculation of stresses are lacking to a considerable extent. While it is true that as early as 1910 Engr. Otto Froelich published in the Journal of the Austrian Society of Engineers and Architects fundamental methods for the accurate calculation of stresses in pipe lines, there is, nevertheless, a still more exact method which the author describes in the present article.

The stresses in the pipe walls are considered by the author as shear stresses induced in the pipe (viewed as a beam) by the weight of water contained therein. It is assumed that these shear stresses are distributed over the circumferential cross-section of the pipe as shown by the equations of equilibrium based on linear elongations and normal stresses; and with this assumption as a basis the shear stresses and bending moments produced by the water pressure are computed for one ring element of the pipe. The calculation of the stresses led to a design of a new type of support bracket for pipe lines, this being based on the idea that in order to avoid excessive local stresses in the thin pipe wall, it is necessary, at the points where the pipe is supported by the bracket, to provide reinforcement rings of proper cross-section that will take up the bearing stresses. The stresses induced in such a ring, as the author shows, are exclusively a function of the shear stresses in the cross-section of the pipe in the immediate neighborhood of the ring, and of the direction of the bearing stresses. The author gives methods for computing all these stresses. This part of the article, being of a mathematical character, is not suitable for abstracting, though of very considerable interest. (*Schweizerische Bauzeitung*, vol. 80, no. 10, Sept. 2, 1922, pp. 105–109, 7 figs., *tm*)

A Table of the Torsional Strength of Bars

Torsional Strength of Bars, Constantin Weber. The author gives a general solution for determining the torsional strength of bars, together with the more important precise and approximate solutions for various problems. He also discusses the influence of normal stresses in the axial direction at considerable twists and the distortion of some of the cross-sections. He claims that some of the data given in engineering handbooks are incorrect and finally presents his results for the various cross-sections in tabular form.

The reasoning of the author may be briefly summarized as follows (The article is mathematical and not suitable for abstracting):

Let us assume that a homogeneous elastic prismatic bar is being stressed by a pair of forces whose plane of action is at right angles to the axis of the bar. This produces a twist of cross-sections of the bar located at a distance of 1 cm. from each other, the twist being through the comparatively moderate angle of torsion δ.

The shear stress T and the moment of torsion M may be expressed by formulas given for every case in Table 1, pp. 738–739, while the functional relation between $T_{\max}$ and M depends on the distance from δ. In the case of long rectangular cross-sections and large angles of twist, owing to the presence of non-uniform elongations, there are normal stresses in the longitudinal fibers of the metal. In the case of two flange cross-sections, the center lines of the flanges lying at the two opposite ends of the cross-section produce, owing to the twisting, an angle of δh_t between them, where h_t is the distance of the flange from its center of gravity. If, on the other hand, because of the construction of the element, the way the body is held, or the symmetrical stresses applied to it, the flanges parallel to each other, a distortion of the flange will take place remain such that the moment of torsion is determined not by the torsional stresses but by the shear stresses $Q = M/h_t$. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 66, nos. 31–32, Aug. 12, 1922, pp. 764–769, *ptA*)

METALLURGY

Chromium Alloy Steel Cast Centrifugally, L. Cammen. This article is probably the first account of the successful production of an alloy-steel casting by the centrifugal process. The chief feature is the attainment directly of a structure which only the most careful and time-consuming forging or rolling, with subsequent heat treatment, can develop in the same kind of alloy steel cast as an ingot. The centrifugally cast chromium steel, unworked and heat treated, is at least equal in structure and properties to similar metal treated by present methods. To this is added the possibility of producing an alloy with higher carbon and chromium than can be secured in ordinary working by present methods. (*Iron Age*, vol. 110, no. 11, Sept. 14, 1922, p. 655, 1 fig., *g*)

Data Concerning the Influence of Velocity of Solidification on Double-Carbide Steels, P. Oberhoffer. The author carried out a series of tests in order to determine to what extent velocity of solidification affects the structure of steels which, according to the theory propounded by Guillet, contain double carbides. This would refer in particular to such ternary systems as iron-carbon-chromium and iron-carbon-tungsten steels.

Daeves (*Zeit. Anorg. Chemie*, 1921, 118, pp. 55–66) has shown that the freezing temperature is not materially affected in the case of steel by additions of chromium and tungsten, and that it lies around 1140 deg. cent. This makes the question of solidification as affecting the structure of steel of importance also in connection with the forging of these steels.

The author carried out a series of tests on steels containing various proportions of carbon and chromium—from 0.585 to 1.510 carbon and from 1.815 to as high as 13.45 per cent chromium—the highest chromium contents corresponding as a rule to the lowest carbon. All the samples were melted in crucibles and some were permitted to cool in the crucible in which they were melted, thus providing a very slow cooling, while others were cast in chill molds.

The original article gives very interesting photomicrographs, which indicate that while slowly cooled samples had a clearly dendritic cross-grained structure, the rapidly cooled samples had a very fine globularized grain.

The most interesting results were obtained, however, when the author forged the ingots from 45 mm. (1.77 in.) square to 15 mm. (0.50 in.) square, which means a reduction of area of nine to one. From photomicrographs given in the original article it would appear that forging stretched out the carbide network which was not held in solution in the direction of the elongation of the bar. The steel which was slowly cooled in the crucible showed even after the forging the ledeburite-like eutectic in its typical form, though distinctly stretched out in the form of strings. On the other hand, the samples cooled in chill molds are practically free from any appearance of eutectic and show the carbide distributed with great uniformity.

Various physical tests (tensile, hardness, etc.) were carried out on the forged samples, and while the results obtained do not give any absolutely clear picture of the relations between the two materials, the values for chill-cast test pieces have been uniformly higher than those for slowly cooled material. (*Stahl und Eisen*, vol. 42, no. 32, Aug. 10, 1922, pp. 1240–1242, 6 figs., *e*)

MOTOR-CAR ENGINEERING (See also Steam Engineering)

Rushmore System of Vapor Cooling for Automobiles

Evaporating Type of Cooling System, A. Ludlow Clayden. The evaporating or vapor cooling system provides for running the cooling water in the jacket at the temperature of boiling, but at the same time preventing the formation of large steam bubbles and condensing the steam formed directly it breaks away.

The system particularly described by the author is the so-called Rushmore system. In it the jacket design of the engine is unchanged and a very small positive pump of gear or piston type is substituted for the centrifugal. The radiator is empty of water, but the outlet from the cylinder jacket goes to the bottom tank and not to the top tank as in the majority of other vapor cooling systems.

The water, therefore, when it begins to warm up, circulates from the bottom tank through the jacket back to the tank, and so on. When steam begins to form it has only one outlet as it cannot back up against the water being continuously forced in at the bottom

of the jacket. Hence the mixture of water and steam is driven down the outlet pipe to the bottom tank. Within this tank is a cross-tube pierced with many small holes above and below. In this the steam and water separate, the steam emerging in bubbles or jets from the upper holes. Immediately on its escape this steam comes in contact with the empty radiator core, into which it rises until the cold metal has condensed it, whereupon the water trickles back to the tank and returns to the jacket.

In this system the formation of large steam pockets is prevented by the forced water flow and the continuous separation of steam from water. The Rushmore system is actually not open freely to the atmosphere, but the top tank is supplied with a relief valve blowing off at 4 or 5 lb. pressure. This gives a boiling point slightly above 212 deg. fahr., but the effect of the valve is more than that. Starting up with the normal quantity of water and with the radiator filled with air, no cooling will occur until the steam begins to force air out through the valve. The system will operate at approximately 220 deg. fahr. consistently until all the air is displaced, which will not happen unless a hill or some other call for full power brings nearly all the radiator surface into play.

On reducing power after such a condition there will be a radiator filled with steam instead of air. The steam condenses promptly and so reduces the pressure, the valve being a blow-off of the non-return type. From that point onward, till air is again deliberately or accidently let in, the vacuum will vary and the boiling point with it. In actual practice the jacket temperature fluctuates from a few degrees under 212 up to a maximum of about 220 deg. fahr.

There are some peculiar advantages in the Rushmore system which deserve particular mention. First, the high temperature of whatever part of the radiator is working, means maximum heat transfer. With water cooling and a mean radiator temperature of 160 deg. fahr. and the air at 80 deg. fahr., the mean difference is 80 deg. With Rushmore's system the working surface is never cooler than 210 deg., which means a difference of 130 deg. fahr. and a consequent increase in radiator efficiency of over 60 per cent. Second, if alcohol is added in winter to prevent freezing, it will be condensed automatically. The alcohol will boil out of the water before steam forms, of course, but it will act precisely like the steam, being condensed in the radiator and recirculated. Since the system is closed there is no loss of alcohol by evaporation.

But perhaps the most important feature of all is that the admission of steam at the bottom of the radiator makes the air displacement automatic, so that the system needs only one very simple and small pump. Also the high average radiator temperature and high rate of transfer mean a small radiator and consequent economy in first cost. Finally, the small radiator and the small pump economize both weight and power. One advantage of the bottom admission also is that the water has no greater distance to trickle back than that through which the steam rises within the core, so that even in the coldest weather, there is no possibility of the water freezing after it is condensed, so long as the engine is running.

It may be added that the Rushmore system can be arranged with a water filler actually on the bottom tank, but that the customary top cap can be used since, if too much water is put in, it is merely blown out just as the air is ejected.

Steam systems appear really likely to show perceptible economies in weight and in power required to operate them, while also providing a nearly perfect constant-temperature control of a fully automatic sort, with an extremely simple release valve as their most intricate part. They are so simple that their principle can be grasped at once by the least intelligent of operators. When closed, as in the type described, loss of water is less likely than with a water system, and when the water is too low the effects are precisely similar to those of the conventional system. (*Automotive Industries*, vol. 47, no. 11, Sept. 14, 1922, pp. 509–511, 2 figs., *d*)

PHYSICS

Experiments on the Ignition of Gases by Sudden Compression, H. T. Tizard and B. R. Pye. In a previous paper the first-mentioned author showed that when a mixture of a combustible gas or vapor with air was suddenly compressed, explosion might take place after an interval the duration of which depended on the temperature reached by the compression.

According to that paper, the observed ignition temperature must depend not only on the properties of the combustible substances, but also on the conditions of experiment and particularly on the rate of loss of heat from the gas at the ignition temperature.

It was further shown that the period of slow combustion before explosion takes place also depends on the properties of the combustible substances, and a theory was briefly developed connecting the "delays" observed at different temperatures with the effect of a rise in temperature on the rate of combustion, i.e., with the so called temperature coefficient of the reaction.

The object of the experiment described in this paper was to test these theories quantitatively and to attempt to deduce from the results the temperature coefficient in certain typical cases.

The indicator used was of the standard Hopkinson optical type, properly calibrated as regards the pressure scale in two ways.

The results of the investigation are summarized as follows:

a Quantitative experiments confirm the view that at the lowest ignition temperature the heat evolved by the combustion of a gas just exceeds that lost to the surroundings.

b From measurements of the rate of loss of heat just below the ignition temperature, and of the intervals between the end of compression and the occurrence of ignition at different temperatures, it is possible to deduce the temperature coefficient of the gaseous reaction.

c The temperature coefficients so obtained are confirmed by the increase in the minimum ignition temperature which is observed when the gas is in a turbulent state.

d The results show that the temperature coefficient of the combustion of carbon bisulphide is much lower than that of heptane or ether. This is in agreement with the relative tendencies of these fuels to detonate in an internal-combustion engine.

e The results do not agree with the radiation theory of chemical reaction.

f Some evidence is put forward to show that the rate of reaction on sudden compression is independent within wide limits of the concentration of the combustible gas, and depends only on the amount of oxygen present. This evidence, however, is incomplete. (*The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, vol. 44, no. 259, July, 1922, pp. 79–121, 11 figs. and one plate, *em*)

POWER-PLANT ENGINEERING

Steam Reducing Valve, C. C. Brown. Description of a valve used in the plant of a large western sugar refinery where live steam is passed in considerable quantities from the 150-lb. main header to the 10-lb. exhaust header.

The specifications for the valve were that it could be set so that it would open up at 9 lb. and allow enough live 150-lb. steam to pass into the exhaust header to bring the exhaust pressure up to 10 lb. and maintain it there. At 10 lb. the valve was shut off.

The valve, made of bronze, is of the balanced chronometer type with self-grinding ports. It is placed in a 6-in. line between the two headers, the 10-lb. exhaust header being further protected by a Cochrane multi-port exhaust atmospheric relief valve of sufficient capacity to relieve the 10-lb. header. The valve is operated by a lever and crank system and is hooked up in such a way that if anything happens to the regulator or hydraulic cylinder, the valve will fall shut. The actual opening and closing of the valve is performed by a hydraulic cylinder controlled by a Spencer-type regulator. This regulator is described and illustrated in the original article. (*Power Plant Engineering*, vol. 26, no. 18, Sept. 15, 1922, pp. 912–913, 4 figs., *d*)

SPECIAL MACHINERY

Use of Geophone in Locating Compressed-Air Leaks, Byron O. Pickard. An Arizona mining company recently demonstrated a new use for the geophone by successfully locating leaks in compressed-air lines which were buried under from $1^1/_2$ to $2^1/_2$ ft. of fine rock fill. The following information is abstracted from data sent to the Bureau of Mines by the superintendent of the mine.

The company has two parallel main compressed-air lines, about one and one-half miles long, buried under an average of two feet

of fine rock fill. One of the lines is a 4-in. high-pressure (1000 lb.) main, and the other a 10-in. low-pressure (90 lb.) main. The two mains are separated by a 10- to 30-ft. interval and run from the compressor plant to the No. 2 shaft, where they are taken underground. A pump is also buried in the immediate vicinity.

Several leaks, not audible enough to be located, were developed in the mains. Various methods were suggested that did not seem practicable to the management. Finally, the company obtained a Bureau of Mines geophone and experimented with it. The first tests were conducted while the pumps were running and while there was noise on the concrete pavement, all of which caused so much vibration in the geophone that it was impossible to detect the leaks.

A second attempt was made at the close of the day shift when the compressors were not operating and when the pumps could be shut down. The valves in the far end of the surface lines were closed, and the lines were pumped to full pressure (90 lb. and 1000 lb., respectively).

Geophone readings were then taken at 7- to 8-ft. intervals directly over the lines. Several leaks—some very large—in the high-pressure line were audible with the geophone at distances varying from 15 to 30 ft. A considerable leak in the low-pressure line was found at a distance of 10 ft. After detecting the leaks, no difficulty was found in locating them exactly.

"At this time," said the superintendent of the mine, "we are unable to state how large a leak must be in order to be located under 2 ft. of loose fill by the geophone. The fill we worked over was quite loose and dry and seemed to be quite unfavorable for the work in question. However, we have no hesitancy in saying that the instrument is a valuable adjunct to our business."

Under date of June 10 he supplements this statement as follows: "Our final observations, so far as air leaks are concerned, are that the instrument can be depended upon to locate the small leaks. I believe that we located everything of importance in our high-pressure line and we located some large leaks in our low-pressure line. However, in the latter there is a section which has been badly corroded, to the point of being full of pin-point leaks; while the aggregate area of these pin holes is considerable, yet we cannot locate the resulting leaks with the geophone."

The geophone will be found useful for many purposes in locating invisible unknown sources of vibration that transmit sound waves detectable by delicate instruments. The geophone used by the Bureau of Mines is an improved type of the French military geophone. The instrument and its uses are described by Alan Leighton in Bureau of Mines Serial No. 2102, published as a Report of Investigations, March 1920. (*Reports of Investigations, Bureau of Mines, Department of the Interior*, Serial No. 2380, Aug., 1922, *g*)

SPECIAL PROCESSES (See also Engineering Materials)

Boscarelli System of Sheet Rolling. Description of a system employed by an Italian society, the particular features of which are as follows: The bars are heated in a large regenerating furnace burning lignite gases. From the furnace they are carried by an inclined belt conveyor to live rollers, and thence through an underground passage to the roughing stands.

Each train consists of two stands of roughing and two stands of finishing mills. In front of each stand there is an automatic device for lifting the bars to the level of the rolls. This lifting device is provided with a controller which arrests the bars in front of the stands.

In the Boscarelli feed system the sheet bars are fed forward by live rollers from the furnace and are automatically lifted off the live rollers when in position by a power-driven lifting table and fed by the table to the mill stand. The device comprises a lifting and tilting table actuated by the piston rod of a cylinder.

The original article shows schematically the ordinary sheet-mill operation and the Boscarelli system, the difference between the two being the greater simplicity of the new system. Thus, in rolling sheets 40 in. by 80 in. in thicknesses from 0.8 mm. to 3 mm. (0.031 in. to 0.118 in.) the sheet bars at the roughing stand are rolled down to the thickness suitable for doubling, thus cutting out the usual operation of reheating the roughened-out sheets. In the new Terni (Rome) plant all sheets 40 in. by 80 in. from 0.2 mm. up to 0.7 mm. thick are rolled with only one reheating operation.

It is stated that the production of sheets 40 in. by 80 in. of usual gages can be brought up to from 70 to 100 tons in 24 hours, or 30 to 40 per cent more than the usual production with a like number of stands. (*The Iron and Coal Trades Review*, vol. 105 no. 2842, Aug. 18, 1922, pp. 220–221, 5 figs., *d*)

STEAM ENGINEERING (See also Marine Engineering)

Winslow Unitary-Type Boiler

The Winslow Automotive Boiler, Chas. B. Page. Description of the Winslow boiler, together with efficiency curves. This boiler is of the unitary system, each section being a complete boiler in itself. The tubes are welded into the headers.

In the boiler as now made, all sections deliver steam to a common equalizing header and receiver water from an equalizing feed pipe

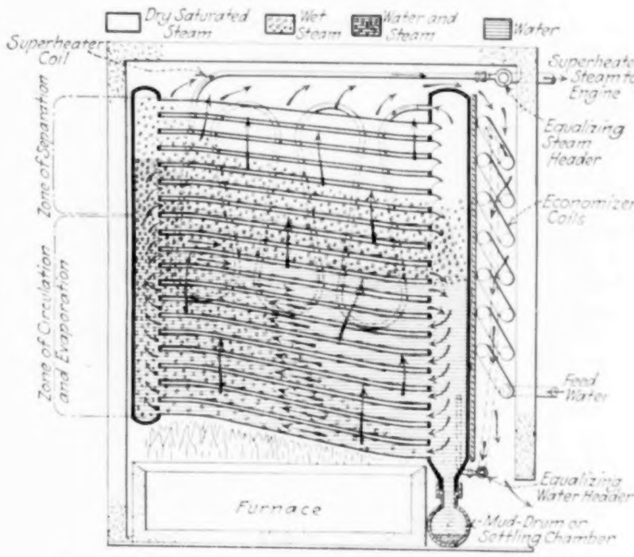


Fig. 7 Cross-Section of the Winslow Automotive Boiler

or mud drum (See Fig. 7). The larger or cold-end header is located well outside of the furnace wall; the smaller or hot-end header is well inside the path of the ascending gases of combustion. Therefore, when heat is applied to the boiler its first action is to expand the water contained in that part of the section in front of the cold-end header. Expansion and ebullition cause the water to flow rapidly toward and upward in the hot-end header. The difference in water levels thus created causes a return flow by gravity to the cold-end header, the rate of circulation following in accordance with the temperature of the fire.

It is said that the boiler can be run dry, even when heated to a bright red, and cold water can be pumped in while it is in that heated condition without causing damage.

One of the boilers used on a car by the author of the paper is 22 in. wide, 34 in. high and 34 in. long. The heating surface, including horizontal water tubes only, is $93^1/_2$ sq. ft. The temperature of saturated steam at the average boiler pressure is 473 deg. fahr. with a superheat of 179 deg.

Data of tests on this boiler at a commercial laboratory are given in the original article. It is stated that evaporation tests were also made at the Armour Institute of Technology. (*The Journal of the Society of Automotive Engineers*, vol. 11, no. 3, Sept., 1922, pp. 265–272, 11 figs., *d*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

Work of A.S.M.E. Boiler Code Committee

THE Sub-Committee on Unfired Pressure Vessels herewith submits a code covering vessels of this type as its progress report.

This Code is to be considered as a preliminary report to be published and given as widespread publicity as possible so that all interested in the manufacture of pressure vessels may have an opportunity to digest thoroughly its provisions. It is hoped that any one interested will make such comments, criticisms, and suggestions as may seem to him advisable. If changes are advocated, specific recommendations of substitute provisions should be made. All communications should be sent to Mr. C. W. Obert, Secretary, Boiler Code Committee, 29 West 39th St., New York, N. Y.

But for the difficulty in reconciling differences of opinion in connection with autogenous welding the Code could have been promulgated long since. Several hearings on the subject of welding generally, notably at the Annual Meeting in December, 1921, and at the Atlanta Meeting, May, 1922, have been held. While there is still much about which there is a wide lack of accord, the situation is much cleared, so that in view of a persistent demand of long standing for a code covering unfired pressure vessels, it seems possible and advisable to proceed. However, the rules covering welding have been exceedingly difficult to formulate. It is the intent not to impose too great restrictions by outlining specific methods to an extent that might eliminate other methods equally good or better, but as far as possible to establish fundamentals applicable to any method and to safeguard by inspection and test to the fullest extent possible. The advance that is being made in autogenous welding is recognized and without doubt more liberal rules than those herein proposed will eventually be permitted.

In view of numerous reported failures of welded vessels, it has been deemed advisable to lean toward the side of safety in bringing out rules governing a relatively new and rapidly growing industry, with the idea of broadening them out as the art advances rather than to be so lenient at the start that resulting accidents might set back its development.

Also it has been deemed advisable to formulate rules which will not unduly handicap the smaller manufacturers of welded tanks, for it will readily be appreciated that what might not be abjectionable to larger manufacturers might be unduly burdensome to smaller ones, and it is the intent not to impose undue hardship. In this connection attention is called to provisions permitting a higher pressure for ammonia vessels than for air vessels. This is done in recognition of the extent to which the manufacture of ammonia containers has been perfected by the larger manufacturers and which degree of perfection can hardly be hoped for in the case of air and other pressure vessels built by less completely equipped makers.

Grateful acknowledgment is made of the work done by the Sub-Committee on Welding of the Boiler Code Committee and of the constructive assistance rendered by the Committees of the American Society of Refrigerating Engineers and the American Welding Society, and also that of the many individuals who have given of their time and knowledge in order to promote the development of the engineering profession and the public welfare.

It is the hope of the Committee that the publication of this Code, which has been several years in preparation, will result in further coöperative suggestions that will make it possible to submit in the very near future a final draft.

Respectfully submitted,

SUB-COMMITTEE OF THE BOILER CODE COMMITTEE ON UNFIRED PRESSURE VESSELS

E. R. FISH, *Chairman*
WM. H. BOEHM
C. E. BRONSON
E. C. FISHER
S. F. JETER
WM. F. KIESEL, JR.
JAMES NEIL
H. V. WILLE.

A.S.M.E. BOILER CODE

PART I—SECTION VI

PRELIMINARY REPORT ON RULES FOR THE CONSTRUCTION OF UNFIRED PRESSURE VESSELS

NOTE: When this Section is incorporated in the Boiler Code, it will be desirable to add the words "AND OTHER PRESSURE VESSELS" at the top of front cover and of the title page, and on page 3 of the Code. Also the sentence in italics on page 3 will be changed to read as follows:

These rules do not apply to boilers *and other pressure vessels* which are subject to Federal inspection and control, nor to vessels for containing hot water for domestic supply.

Also to insert, after bracket in line beginning Part I, the following:

"SECTION VI—UNFIRED PRESSURE VESSELS"

CLASSIFICATION

U-1. The vessels to which these rules apply are divided into three classes:

Class A: Vessels for containing liquids at temperatures above their boiling points at atmospheric pressure, inflammable substances, or any gas, over 6 in. in diameter, more than 1.5 cu. ft. in volume and carrying over 15 lb. pressure per sq. in., except pressure vessels used in domestic water supply and those provided for in Class C.

Class B: Vessels for containing liquids, the temperatures of which are under control so as to be below their boiling points at atmospheric pressure, over 9 in. in diameter, more than 4 cu. ft. in volume and carrying over 30 lb. pressure per sq. in. but not to exceed 125 lb. pressure per sq. in. For pressures over 125 lb. per sq. in., the rules in Class A vessels apply.

Class C: Vessels for carrying on cooking or similar heating processes of food, medicinal or other chemical preparations, having surfaces coated with glass or similar enamel; and limited to a maximum allowable working pressure of 150 lb. per sq. in.

U-2. Safety Appliances. In cases where there is a possibility that the maximum allowable pressure may be exceeded, all pressure vessels shall be protected by safety and relief valves and indicating and controlling devices as will insure their safe operation. All such devices shall be so located and installed that they cannot readily be rendered inoperative. The relieving capacity of safety valves shall be such as to prevent a rise of pressure in the vessel of more than 6 per cent above the maximum allowable working pressure and their discharges carried to a safe place.

U-3. Corrosive Chemicals. All presssure vessels which are to contain substances having a corrosive action upon the metal of which the vessel is constructed should be designed for a pressure in excess of that which it is to carry, to safeguard against early rejection.

CLASS-A VESSELS

U-4. Class A vessels may be constructed of any metal other than steel of qualities herein specified, if the following rules are complied with:

The maximum allowable unit working stress used in any of the metals selected except as otherwise provided in this section, shall be determined by the following formula:

$$S = 0.0125\,El\,(e + 8), \text{ but not more than } 0.4\,El, \text{ or } 0.2T$$

where S = maximum allowable unit working tension stress, lb. per sq. in.

El = elastic limit of material used

T = tensile strength of material used

e = elongation of material used, in per cent, in 8 in.

Unit working stress in rivets in single shear shall be taken as 80 per cent of S.

Working stress in rivets in double shear shall be double that of single shear.

Staybolt values other than those given in par. U-33 for allowable stress per sq. in. of net section shall be taken as follows:

When e is not over 10 per cent, = 60 per cent of S
When e is from 10 to 20 per cent, = 70 per cent of S
When e is over 20 per cent, = 80 per cent of S.

U-5. Class A vessels may be constructed of steel of qualities specified in Par. U-7.

U-6. Specifications are given in the Rules for Power Boilers, Pars. 23–178, for the important materials that may be used in the construction of pressure vessels, and where such materials are used they shall conform thereto. The elastic limit of steel may be taken as $^{5}/_{9}$ of the yield point.

U-7. Steel plates for any part of a pressure vessel required to resist stress produced by internal pressure, shall be of flange or firebox quality as designated in the Specifications for Boiler Plate Steel, except as hereinafter provided.

U-8. Steel plates and other material for any part of a pressure vessel which is to be constructed with other than riveted joints or by a combination of the two methods must be of qualities as provided in the specifications for the particular kind of joint to be used.

Ultimate Strength of Material Used in Computing Joints

U-9. Tensile Strength of Steel Plate. In determining the maximum allowable working pressure, the tensile strength used in the computations for steel plates shall be that stamped on the plates where herein provided, which is the minimum of the stipulated range, or 55,000 lb. per sq. in. for all steel plates, except for special grades having a lower tensile strength. If plates are to be subjected to a temperature in excess of 600 deg. fahr. the weakening effect on the tensile strength due to the temperature must be taken into consideration when calculating stresses, and in applying the hydrostatic test.

U-10. Crushing Strength of Steel Plate. The resistance to crushing of steel plate shall be taken at 95,000 lb. per sq. in. of cross-sectional area.

U-11. Strength of Rivets in Shear. In computing the ultimate strength of rivets in shear, the following values in pounds per square inch of the cross-sectional area of the rivet shank shall be used:

Iron rivets in single shear	38,000
Iron rivets in double shear	76,000
Steel rivets in single shear	44,000
Steel rivets in double shear	88,000

The cross-sectional area used in the computations shall be that of the rivet shank after driving.

U-12. Thickness of Plates. The minimum thickness of any plate under pressure shall be $^{1}/_{4}$ in., except that for diameters 24 in. and under the minimum thickness may be $^{3}/_{16}$ in.,

U-13. The minimum thicknesses of shell plates, and dome plates after flanging, shall be as follows:

When the Diameter of Shell is

24 In. or Under	Over 24 In. to 36 In.	Over 36 In. to 54 In.	Over 54 In. to 72 In.	Over 72 In.
$^{3}/_{16}$ in.	$^{1}/_{4}$ in.	$^{5}/_{16}$ in.	$^{3}/_{8}$ in.	$^{1}/_{2}$ in.

U-14. The minimum thickness of butt straps for double strap joints shall be as given in Table U-1. Intermediate values shall be determined by interpolation. For plate thickness exceeding $1^{1}/_{4}$ in., the thickness of the butt straps shall be not less than two-thirds of the thickness of the plate.

TABLE U-1 MINIMUM THICKNESSES OF BUTT STRAPS

Thickness of shell plates, in.	Minimum thickness of butt straps, in.	Thickness of shell plates, in.	Minimum thickness of butt straps, in.
$^{3}/_{16}$	$^{3}/_{16}$		
$^{1}/_{4}$	$^{1}/_{4}$	$^{17}/_{32}$	$^{7}/_{16}$
$^{9}/_{32}$	$^{1}/_{4}$	$^{9}/_{16}$	$^{7}/_{16}$
$^{5}/_{16}$	$^{1}/_{4}$	$^{5}/_{8}$	$^{1}/_{2}$
$^{11}/_{32}$	$^{1}/_{4}$	$^{3}/_{4}$	$^{1}/_{2}$
$^{3}/_{8}$	$^{5}/_{16}$	$^{7}/_{8}$	$^{5}/_{8}$
$^{13}/_{32}$	$^{5}/_{16}$	1	$^{11}/_{16}$
$^{7}/_{16}$	$^{3}/_{8}$	$1^{1}/_{8}$	$^{3}/_{4}$
$^{15}/_{32}$	$^{3}/_{8}$	$1^{1}/_{4}$	$^{7}/_{8}$
$^{1}/_{2}$	$^{7}/_{16}$		

Construction and Maximum Allowable Working Pressures

U-15. The maximum allowable working pressure is that at which a pressure vessel may be operated as determined by employing the factors of safety, stresses, and dimensions designated in these Rules.

Wherever the term maximum allowable working pressure is used herein, it refers to gage pressure, or the pressure above the atmosphere, in pounds per square inch.

U-16. The maximum allowable working pressure on the shell of a pressure vessel or drum shall be determined by the strength of the weakest course, computed from the thickness of the plate, the tensile strength stamped thereon, as provided for in the Specifications for Boiler Plate Steel, the efficiency of the longitudinal joint, the inside diameter of the course, and the maximum allowable unit working stress.

$$\frac{S \times t \times E}{R} = \text{maximum allowable working pressure, lb. per sq. in.}$$

where S = maximum allowable working tension stress in lb. per sq. in.
= 11,000 lb. per sq. in. for plate stamped 55,000 lb. per sq. in. as herein provided, and 10,000 lb. per sq. in. for special shell plates for welding (Pars. U-100 and U-101).
t = minimum thickness of shell plates in weakest course, in.
E = efficiency of longitudinal joint
R = inside radius of the weakest course of the shell or drum, in.

In seamless cylinders a joint efficiency of 100 per cent may be used.

Joints

U-17. The efficiency of a joint is the ratio which the strength of the joint bears to the strength of the solid plate. In the case of a riveted joint this is determined by calculating the breaking strength of a unit section of the joint, considering each possible mode of failure separately, and dividing the lowest result by the breaking strength of the solid plate of a length equal to that of the section considered.

U-18. The distance between the center lines of any two adjacent rows of rivets, or the "back pitch" measured at right angles to the direction of the joint, shall have the following minimum values:

a If $\frac{P}{D}$ is 4 or less, the minimum values shall be $1^{3}/_{4}D$

b If $\frac{P}{D}$ is over 4, the minimum value shall be:

$$1^{3}/_{4}D + 0.1\,(P - 4D)$$

where P = pitch of rivets in outer row where a rivet in the inner row comes midway between two rivets in the outer row, in.
P = pitch of rivets in the outer row less pitch of rivets in the inner row where two rivets in the inner row come between two rivets in the outer row, in. (It is here assumed that the joints are of the usual construction where the rivets are symmetrically spaced)
D = diameter of the rivet holes, in.

U-19. On longitudinal joints, the distance from the centers of rivet holes to the edges of the plates, except rivet holes in the ends of butt straps, shall be not less than $1^{1}/_{2}$ and not more than $1^{3}/_{4}$ times the diameter of the rivet holes; this distance to be measured from the center of the rivet holes to the calking edge of the plate before calking.

U-20. *a* The strength of circumferential joints of pressure vessels the heads of which are not stayed by tubes or through braces, shall be at least 50 per cent of that required for the longitudinal joints of the same structure.

b When 50 per cent or more of the load which would act on an unstayed solid head of the same diameter as the shell, is relieved by the effect of through tubes or stays, in consequence of the holding power of the tubes and stays, the strength of the circumferential joints in the shell shall be at least 35 per cent of that required for the longitudinal joints.

U-21. The riveted longitudinal joints of a shell or drum which exceed 48 in. in diameter, shall be of butt and double-strap construction. This rule does not apply to the portion of a shell which is staybolted to the inner sheet.

U-22. The longitudinal joints of a shell or drum not more than

48 in. in diameter, may be of lap-riveted construction; but the maximum allowable working pressure for lap-riveted construction shall not exceed 150 lb. per sq. in.

U-23. Butt straps and the ends of shell plates forming the longitudinal joints shall be rolled or formed by pressure, not blows, to the proper curvature.

U-24. Domes. The requirements of Pars. U-21 and U-22 shall apply to riveted longitudinal joints of domes except that for domes 24 in. and less in diameter for pressures exceeding 100 lb., the longitudinal joints may be lap-riveted if the factor of safety is not less than 8.

The flange of a dome 24 in. or over in diameter shall be double-riveted to the boiler shell. Where the flange of the dome is the only reinforcement for attachment to the shell, the diameter of the dome shall not exceed one-half the diameter of the shell or barrel of the boiler.

Flanges of domes shall be formed with a corner radius, measured on the inside, of at least twice the thickness of the plate for plates 1 in. thick or less, and at least three times the thickness of the plate for plates over 1 in. in thickness.

Dished Heads

U-25. Convex Heads. The thickness required in an unstayed dished head with the pressure on the concave side, when it is a segment of a sphere, shall be calculated as follows:

Where $P \times L$ is equal to or less than 4860, the formula to be used shall be as follows:

$$t = \frac{PL}{13{,}200}$$

Where $P \times L$ is greater than 4860, then the following formula shall be used:

$$t = \frac{PL}{20{,}000} + {}^1/_8$$

where t = thickness of plate, in.
P = maximum allowable working presure, lb. per sq. in.
L = radius to which the head is dished, in.

Where two radii are used, the longer shall be taken as the value of L in the formula.

Where the radius is less than 80 per cent of the diameter of the shell or drum to which the head is attached, the thickness shall be at least that found by the formula by making L equal to 80 per cent of the diameter of the shell or drum.

Concave Heads. Dished heads with the pressure on the convex side shall have a maximum allowable working pressure equal to 60 per cent of that for heads of the same dimensions with the pressure on the concave side.

When a dished head has a manhole opening, the thickness as found by these Rules shall be increased by not less than ${}^1/_8$ in. over that called for by the formula.

U-26. When dished heads are of a less thickness than called for by Par. U-25, they shall be stayed as flat surfaces, no allowance being made in such staying for the holding power due to the spherical form.

U-27. The corner radius of an unstayed dished head measured on the concave side of the head shall not be less than three times the plate thickness up to $t = {}^1/_8$, and not less than $3t^2$ for thicker plates.

U-28. A manhole opening in a dished head shall be flanged to a depth measured from the outside of not less than three times the required thickness of the head.

Braced and Stayed Surfaces

U-29. The maximum allowable working pressure for various thicknesses of braced and stayed flat plates and those which by these Rules require staying as flat surfaces with braces or staybolts of uniform diameter symmetrically spaced, shall be calculated by the formula:

$$P = C \times \frac{T^2}{p^2}$$

where

P = maximum allowable working pressure, lb. per sq. in.
T = thickness of plate in *sixteenths* of an inch.
p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined, in.
C = 112 for stays screwed through plates not over ${}^7/_{16}$ in. thick with ends riveted over
C = 120 for stays screwed through plates over ${}^7/_{16}$ in. thick with ends riveted over
C = 135 for stays screwed through plates and fitted with single nuts outside of plate
C = 150 for stays with heads not less than ${}^1/_3$ times the diameter of the stays, screwed through plates or made a taper fit and having the heads formed on the stays before installing them and not riveted over, said heads being made to have a true bearing on the plate
C = 175 for stays fitted with inside and outside nuts and outside washers where the diameter of washers is not less than $0.4p$ and thickness not less than T.

If a flat plate not less than ${}^3/_8$ in. thick is strengthened with a doubling plate covering the full area of the stayed surface and securely riveted thereto and having a thickness of not less than ${}^2/_3$ T, then the value of T in the formula shall be three-quarters of the combined thickness of the plate and doubling plate but not more than one and one-half times the thickness of the plate, and the value of C given above may also be increased 15 per cent.

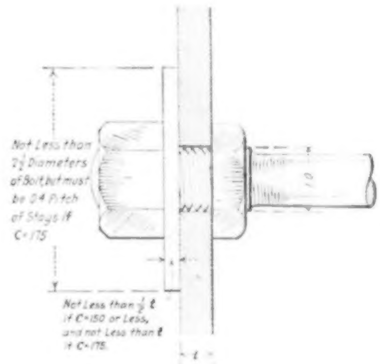


Fig. U-1 Acceptable Proportions for Ends of Through Stays

When two sheets are connected by stays and but one of these sheets requires staying, the value of C is governed by the thickness of the sheet requiring staying.

Acceptable proportions for the ends of through stays with washers are indicated in Fig. U-1.

U-30. Staybolts. The ends of screwed staybolts shall be riveted over or upset by equivalent process.

U-31. Structural Reinforcements. When channel irons or other members are securely riveted to the heads for attaching through stays, the transverse stress on such members shall not exceed 12,500 lb. per sq. in. In computing the stress, the section modulus of the member shall be used without addition for the strength of the plate. The spacing of the rivets over the supported surface shall be in conformity with that specified for staybolts.

If the outstanding legs of the two members are fastened together so that they act as one member in resisting the bending action produced by the load on the rivets attaching the members to the head of the pressure vessel, and provided that the spacing of these rivets attaching the members to the head is approximately uniform, the members may be computed as a single beam uniformly loaded and supported at the points where the through braces are attached.

U-32. *a* The maximum spacing between centers of rivets attaching the crowfeet of braces to the braced surface, shall be determined as in Par. U-29 using 135 for the value of C.

b The maximum between the inner surface of the shell and lines parallel to the surface of the shell passing through the centers of the rivets attaching the crowfeet of braces to the head, shall be determined by the formula in Par. U-29, using 175 for the value of C.

c The maximum distance between the inner surface of the shell and the centers of braces of other types shall be determined by the

formula in Par. U-29, using a value of C equal to 1.3 times that value of C which applies to the thickness of plate and type of stay as therein specified.

d In applying these Rules and those in Par. U-29 to a head or plate having a manhole or reinforced opening, the spacing applies only to the plate around the opening and not across the opening.

U-33. The formula in Par. U-29 was used in computing Table U-2. Where values for screwed stays with ends riveted over are required for conditions not given in Table U-2, they may be computed from the formula and used, provided the pitch does not exceed $8\frac{1}{2}$ in.

U-34. The distance from the edge of a staybolt hole to a straight line tangent to the edges of the rivet holes may be substituted for p for staybolts adjacent to the riveted edges bounding a stayed surface. When the edge of a stayed plate is flanged, p shall be measured from the inner surface of the flange, at about the line of rivets to the edge of the staybolts or to the projected edge of the staybolts.

TABLE U-2 MAXIMUM ALLOWABLE PITCH, IN INCHES OF SCREWED STAYBOLTS, END RIVETED OVER

Pressure, Lb. Per Sq. In.	Thickness of Plate, In. — $\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$
	Maximum Pitch of Staybolts, In.						
100	$5\frac{1}{4}$	$6\frac{3}{8}$	$7\frac{3}{8}$	...	...	...	...
110	5	6	7	$8\frac{3}{8}$	...	...	...
120	$4\frac{3}{4}$	$5\frac{3}{4}$	$6\frac{3}{4}$	8	...	...	...
125	$4\frac{3}{4}$	$5\frac{5}{8}$	$6\frac{5}{8}$	$7\frac{3}{4}$	...	...	...
130	$4\frac{5}{8}$	$5\frac{1}{2}$	$6\frac{1}{2}$	$7\frac{5}{8}$	...	...	...
140	$4\frac{1}{2}$	$5\frac{3}{8}$	$6\frac{1}{4}$	$7\frac{3}{8}$	$8\frac{3}{8}$	...	...
150	$4\frac{1}{4}$	$5\frac{1}{8}$	6	$7\frac{1}{8}$	8	...	...
160	$4\frac{1}{8}$	5	$5\frac{7}{8}$	$6\frac{7}{8}$	$7\frac{3}{4}$	...	...
170	4	$4\frac{7}{8}$	$5\frac{5}{8}$	$6\frac{3}{4}$	$7\frac{1}{2}$	$8\frac{3}{8}$	...
180	...	$4\frac{3}{4}$	$5\frac{1}{2}$	$6\frac{1}{2}$	$7\frac{3}{8}$	$8\frac{1}{8}$	...
190	...	$4\frac{5}{8}$	$5\frac{3}{8}$	$6\frac{3}{8}$	$7\frac{1}{8}$	$7\frac{7}{8}$	...
200	...	$4\frac{1}{2}$	$5\frac{1}{4}$	$6\frac{1}{8}$	7	$7\frac{3}{4}$	$8\frac{1}{2}$
225	...	$4\frac{1}{4}$	$4\frac{7}{8}$	$5\frac{7}{8}$	$6\frac{1}{2}$	$7\frac{1}{4}$	8
250	...	4	$4\frac{5}{8}$	$5\frac{1}{2}$	$6\frac{1}{4}$	$6\frac{7}{8}$	$7\frac{5}{8}$
300	...	...	$4\frac{1}{4}$	5	$5\frac{5}{8}$	$6\frac{1}{4}$	7

U-35. The diameter of a screw stay shall be taken at the bottom of the thread, provided this is the least diameter.

U-36. The least cross-sectional area of a stay shall be taken in calculating the allowable stress, except that when the stays are welded and have a larger cross-sectional area at the weld than at some other point, in which case the strength at the weld shall be computed as well as in the solid part and the lower value used.

U-37. Holes for screw stays shall be drilled full size or punched not to exceed $\frac{1}{4}$ in. less than full diameter of the hole for plates over $\frac{5}{16}$ in. in thickness, and $\frac{1}{8}$ in. less than the full diameter of the hole for plates not exceeding $\frac{5}{16}$ in. in thickness, and then drilled or reamed to the full diameter. The holes shall be tapped fair and true, with a full thread.

U-38. The ends of steel stays upset for threading, shall be thoroughly annealed.

U-39. *a* The full pitch dimensions of the stays shall be employed in determining the area to be supported by a stay, and the area occupied by the stay shall be deducted therefrom to obtain the net area. The product of the net area in square inches by the maximum allowable working pressure in lb. per sq. in., gives the load to be supported by the stay.

b The maximum allowable stress per square inch at point of least net cross-sectional area of stays and staybolts shall be as given in Table U-3. In determining the net cross-sectional area of drilled or hollow staybolts, the cross-sectional area of the hole shall be deducted.

U-40. Where it is impossible to calculate with a reasonable degree of accuracy the strength of a pressure vessel or any part thereof, a full-sized sample shall be built by the manufacturer and tested to destruction in the presence of the Boiler Code Committee or one or more representatives of the Boiler Code Committee appointed to witness such test.

Riveting

U-41. Drilling of Holes. All rivet holes and holes in braces and lugs shall be drilled full size or they may be punched not to exceed $\frac{1}{4}$ in. less than full diameter for material over $\frac{5}{16}$ in. in thickness, and $\frac{1}{8}$ in. less than full diameter for material not exceeding $\frac{5}{16}$ in. in thickness. Plates, butt straps, braces, heads and lugs shall be firmly bolted in position by tack bolts for drilling or reaming all rivet holes in plates except those used for the tack bolts.

U-42. Rivets. Rivets shall be of sufficient length to completely fill the rivet holes and form heads at least equal in strength to the bodies of the rivets. Forms of rivet heads that will be acceptable are shown in Fig. U-2.

TABLE U-3 MAXIMUM ALLOWABLE STRESSES FOR STAYS AND STAYBOLTS

Description of Stays	Stresses, Lb. per Sq. In. — For lengths between supports not exceeding 120 diameters	For lengths between supports exceeding 120 diameters
a Unwelded or flexible stays less than 20 diameters long, screwed through plates with ends riveted over	7,500	.....
b Hollow steel stays less than 20 diameters long, screwed through plates with ends riveted over	8,000	.....
c Unwelded stays and unwelded portions of welded stays, except as specified in line *a* and line *b*	9,500	8,500
d Steel through stays exceeding $1\frac{1}{2}$ in. diameter	10,400	9,000
e Welded portions of stays	6,000	6,000

Calking

U-43. Calking. The calking edges of plates, butt straps and heads shall be beveled to an angle not sharper than 70 deg. to the plane of the plate, and as near thereto as practicable. Every portion of the sheared surfaces of the calking edges of plates, butt straps and heads shall be planed, milled or chipped to a depth of not less than $\frac{1}{8}$ in. Calking shall be done with a round-nosed tool.

Manholes

U-44. Manholes and Handholes. An elliptical manhole opening shall be not less than 11 by 15 in., or 10 by 16 in. size. A circular manhole opening shall be not less than 15 in. in diameter.

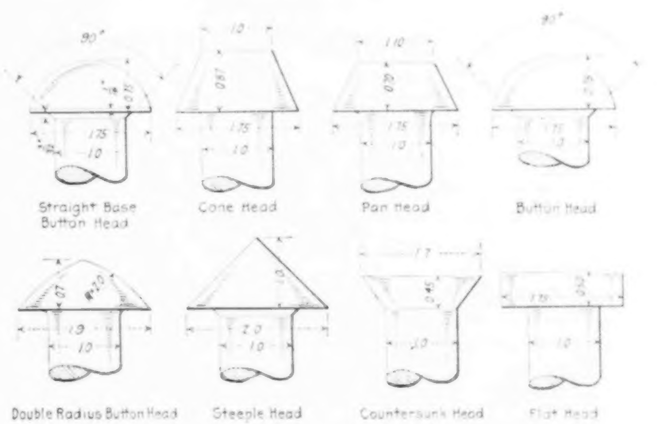


Fig. U-2 Acceptable Forms of Rivet Heads

U-45. A manhole reinforcing ring when used, shall be of steel or wrought iron, and shall be at least as thick as the shell plate.

U-46. The strength of the rivets in shear on each side of a manhole frame or reinforcing ring shall be at least equal to the tensile strength of the maximum amount of the shell plate removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell, through the manhole, or other opening.

U-47. Manhole plates shall be of wrought steel or shall be steel castings.

Threaded Openings

U-48. A pipe connection 1 in. in diameter or over shall have not less than the number of threads given in Table U-4. Diameters of less than 1 in. pipe size shall have at least four threads.

If the thickness of the material in the pressure vessel is not sufficient to give such number of threads, the opening shall be reinforced by a pressed steel, cast steel, or bronze composition flange, or plate, or a boss may be built up by an autogenous welding process, so as to provide the required number of threads.

When the maximum allowable working pressure exceeds 125 lb. per sq. in., a connection riveted to the pressure vessel to receive a flanged fitting shall be used for all pipe openings over 3 in. pipe size.

TABLE U-4 MINIMUM NUMBER OF PIPE THREADS FOR CONNECTIONS

Size of pipe connection, in.	1 and $1^1/_4$	$1^1/_2$ and 2	$2^1/_2$ to 4 inclusive	$4^1/_2$ to 6 inclusive	7 and 8	9 and 10	12
Number of threads per inch	$11^1/_2$	$11^1/_2$	8	8	8	8	8
Minimum number threads required in opening	4	5	7	8	10	12	13
Minimum thickness of material required to give above number of threads, in.	0.0348	0.435	0.875	1	1.25	1.5	1.625

U-49. Supports. All vessels must be so supported as to properly distribute the stresses arising from the weight of the vessel and contents. Class A vessels over 16 in. in diameter must be so arranged that the interior and exterior of the vessel may be inspected. In the case of vertical cylindrical vessels subject to corrosion, the bottom head, if dished, must be with the pressure on the concave side to insure complete drainage.

Lugs or brackets when used to support a vessel shall be properly fitted to the surfaces to which they are attached. The shearing and crushing stresses on steel and rivets used for attaching the lugs or brackets shall not exceed 8 per cent of the strength given in Pars. U-10 and U-11.

U-50. In laying out the plates for Class A pressure vessels, care must be taken to leave one of the stamps required in the Specifications for Boiler Plate Steel, so located as to be plainly visible when the vessel is completed; or in case these are unavoidably cut out, the heat number, quality of plate, minimum tensile strength and maker's name shall be accurately transferred as to form by the pressure vessel manufacturer, to a location where these stamps will be visible. The form of stamping shall be such that it can be readily distinguished from the plate maker's stamping.

U-51. Every Class A pressure vessel shall conform in all details with these rules, and when so constructed shall be stamped with the legend provided for in Par. U-54.

U-52. Each vessel constructed under these rules shall be tested under hydrostatic pressure to 50 lb. in excess of the working pressure when same does not exceed 100 lb., and to $1^1/_2$ times the working pressure for pressures above 100 lb.

U-53. Every Class A pressure vessel shall be inspected at least once by a state or municipal inspector of boilers, or an inspector employed regularly by an insurance company which is authorized to do a boiler insurance business in the state in which the vessel is built, and in the state in which it is to be used, if known, which inspection shall be when the hydrostatic pressure test is on. A data sheet shall be filled out and signed by the manufacturer and the inspector, which data sheet together with the stamping on the vessel, will denote that it was constructed in accordance with these rules. Every Class A pressure vessel fabricated in whole or in part by a welding process shall, when the size of the shell permits, be internally inspected before being finally closed to inspection.

U-54. Each such pressure vessel shall be marked in the presence of the inspector, A.S.M.E. Std. P.V., the class, and with the manufacturer's name and serial number, and working pressure. These markings shall be stamped with letters and figures at least $^5/_{16}$ in. high on some conspicuous portion of the vessel, preferably near a manhole, if any, or handhole. These stamps shall be arranged substantially as follows:

A.S.M.E. STD. P.V.

A

Serial No..................

Max. W.P..................lb.

Mfrs. No..................

....
(Mfrs. Name)

and shall not be covered with insulating or other material. The symbol authorized for use on power boilers shall not be used on pressure vessels.

CLASS-B VESSELS

U-55. Vessels of this class may be constructed of untested open-hearth steel in which case the maximum allowable unit working stress shall be 10,000 lb. per sq. in.

U-56. Crushing and shearing values and butt strap thicknesses shall be as specified in Pars. U-10, U-11, and U-14.

U-57. Maximum allowable working pressure and calculation of riveted joints shall be as specified in Pars. U-15, U-16, U-17, U-18, and U-20, except that the maximum allowable unit working stress in Par. U-16 shall be 13,750 lb. per sq. in. for plate stamped 55,000 lb. per sq. in. as herein provided, and 12,500 lb. per sq. in. for special steel plate for welding (Pars. U-100 and U-101).

U-58. The longitudinal joint of a shell or drum may be of lap-riveted construction.

U-59. Use Pars. U-25, U-26, U-27, and U-28 for calculating the thickness of heads, modifying the formula in Par. U-25 to read as follows:

$$t = \frac{PL}{18{,}000}$$

U-60. The design of braced and stayed surfaces shall be in accordance with the rules provided in Pars. U-29, U-30, U-31, U-32, U-33, U-34, U-35, U-36, U-37, U-38, and U-39, except that the working pressure determined may be increased 25 per cent.

U-61. All rivet and staybolt holes may be punched full size.

U-62. Rivets shall be of sufficient length to fill the rivet holes and form full heads.

U-63. Calking shall be done with a round-nosed tool.

U-64. The provisions for manholes and handholes as given in Pars. U-44, U-45, and U-46 shall apply to Class B vessels.

U-65. Manhole plates may be of wrought steel, steel castings, or cast iron.

U-66. The provisions of Par. U-48 shall be followed for pipe connections.

U-67. The provisions of Pars. U-2, U-3, and U-49 shall govern safety appliances, supports, etc.

U-68. The provisions of Par. U-4 shall apply to vessels of Class B, except that the formula given shall be modified as follows:

$$S = 0.0125\,El\,(e + 16), \text{ but not more than } 0.65El \text{ or } 0.25T$$

U-69. Each vessel constructed under these rules shall be tested under hydrostatic pressure to 50 lb. in excess of the working pressure when same does not exceed 100 lb., and to $1^1/_2$ times the working pressure for pressures above 100 lb.

U-70. Pressure vessels constructed in accordance with the rules for Class B vessels may be stamped by the manufacturer only, with the legend provided in Par. U-71. When the manufacturer elects to so stamp vessels of this class, records of the kind of material and all details of construction must be kept and a data sheet giving this information must be furnished the purchaser or user if demanded.

U-71. When Class B pressure vessels are stamped in order to indicate that they comply with this Code, the provisions of Par. U-54 shall apply, except that the class letter shall be B instead of A, and the presence of an inspector is not necessary.

CLASS-C VESSELS

U-72. Material. All vessels under this classification shall be made of steel plate not under $^1/_4$ in. nor more than $^5/_8$ in. in thickness and welded by the oxy-acetylene, electric-arc or forge-welding processes. If forge welding is used the requirements of Pars. U-111 to U-135 shall be followed. Except for forge welding, all plates shall conform to the following specifications:

a Manufacture: The plate shall be made by the open-hearth process and must be free from physical defects such as cracks, seams, scabs, splinters, slivers, etc. Any plate not conforming to these specifications may be rejected.

b Chemical Analysis: The composition shall be as follows:

Carbon	0.08–15 per cent (12 preferred)
Manganese	0.30–60 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.05 per cent
Silicon	not over 0.25 per cent

c Physical Properties: The plate shall be of the following physical properties:

Tensile strength, max., lb. per sq. in.	60,000
Yield point, min., lb. per sq. in.	26,000
Elongation in 8 in., min., per cent	$\frac{1{,}500{,}000}{\text{Tensile Strength}}$

d The yield point shall be determined by the drop of the beam of the testing machine at a speed not exceeding 1/2 in. per minute.

e The plate shall be of good welding quality.

U-73. The maximum allowable working pressure for single-shell vessels shall be determined by the following formula:

$$P = \frac{4500\ t}{R}$$

where t = thickness of plate in in.
R = inside radius

U-74. The formula given in U-25 shall be used in calculating the thickness of heads necessary for the various pressures and diameters.

U-75. The ratio of diameter to thickness of plate in no case shall exceed 320.

U-76. Welded Seams. All surfaces to be welded must be cleaned preparatory to welding, by sandblasting, chipping, or any other approved method of cleaning.

U-77. For metallic arc welding the following specification for welding wire shall apply:

Carbon	not over 0.18
Manganese	0.40–0.60
Silicon	not over 0.06
Phosphorus	not over 0.04
Sulphur	not over 0.04

Any approved brand of arc-welding wire conforming to the above specification may be used which has been found by practice to give good results. The wire shall be cold drawn and must flow freely and evenly. It may be used bare, coated or covered.

For acetylene welding any approved brand of gas welding wire may be used.

U-78. Class C vessels will be considered under two types, single-shell vessels and jacketed vessels.

U-79. Longitudinal and circumferential seams of single-shell vessels welded by either the oxy-acetylene or electric-arc processes shall be double-V welded.

The weld on the inside of single-shell vessels may be ground flush with the surface of the plate.

U-80. Jacketed or double-shell vessels may be of two types, one in which one of the heads of the inner vessel forms the sealer apron for the jacket, and one in which the sealer apron is joined to the shell of the inner tank at some point between the heads, forming a partially jacketed vessel.

U-81. In all cases the inner vessel of a jacketed tank shall be of the same construction as a single-shell tank.

U-82. The longitudinal seam of the jacket and the seam joining the head to shell on all jacketed vessels welded by either the oxy-acetylene or electric-arc process shall be double-welded.

U-83. In jacketed vessels where the sealer apron is welded to the cylinder of the inner tank, the weld may be made from one side only, provided the thickness of the metal deposited is equal to or greater than the thickness of the sealer apron.

U-84. In jacketed vessels where the top head of the inner tank forms the sealer apron, the head may be welded to the shell of the inner tank from the inside only, provided the thickness of the weld after grinding is equal to or greater than the thickness of the head.

U-85. All cylinders shall be rerolled after welding.

U-86. All vessels shall be tested to a hydrostatic pressure equal to the working pressure.

VESSELS CONSTRUCTED WITH WELDED OR BRAZED JOINTS

U-87. All Class B vessels may be fabricated by means of autogenous or forge welding, or brazing provided the rules governing the method adopted and as given in Pars. U-92 to U-151 of the Code are followed.

U-88. The following Class A vessels may be fabricated by means of autogenous welding with the exception of longitudinal seams when the rules given in Pars. U-92 to U-110 are followed:

a Air tanks in which the pressure does not exceed 150 lb. per sq. in.

b Tanks for containing other than noxious or explosive gases other than ammonia, when the pressure does not exceed 150 lb. per sq. in.

c Tanks for containing liquids other than those which are noxious or explosive, when the pressure does not exceed 150 lb. per sq. in.

d Tanks for containing ammonia shall be built for a maximum allowable working pressure of 250 lb. per sq. in. and installed in connection with safety valves to prevent this pressure being exceeded.

U-89. Class A vessels for any uses or pressures may be fabricated by means of forge welding when the rules given in Pars. U-111 to U-135 are followed.

U-90. Class A vessels for any pressures and for any temperatures not exceeding 450 deg. fahr., may be fabricated by means of the brazing process when the rules given in Pars. U-136 to U-151 are followed.

U-91. The design and construction of all vessels with welded or brazed joints shall conform to and be based upon the formulas, specifications and data which are given in this Code.

RULES FOR THE AUTOGENOUS PROCESS OF WELDING

U-92. Processes. The autogenous process, so-called, shall consist of welding by means of either the oxy-acetylene process or the electric-arc process, using a metallic electrode, either bare, coated or covered.

U-93. When properly welded by the autogenous process, the strength of a joint may be taken as a maximum of 28,000 lb. per sq. in. of net section of plate.

U-94. Terms. The term *base metal* as used herein shall mean the metal or metals of which the vessel is constructed and which are joined together by the welded seam.

U-95. Filling Material. The term "filling material" as used herein shall mean the weld rod, filling rod, electrode or other metal which is used to join together two sections of the base metal, or metals. The following material has been shown to give acceptable results and may be used:

For Oxy-Acetylene Welding

Carbon	not over 0.06 per cent
Silicon	not over 0.08 per cent
Manganese	not over 0.15 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.04 per cent
or	
Carbon	0.18 to 0.22 per cent
Manganese	0.40 to 0.50 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.04 per cent
Nickel	3.0 to 3.5 per cent

For Electric-Arc Welding

Carbon	not over 0.06 per cent
Silicon	not over 0.08 per cent
Manganese	not over 0.15 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.04 per cent
or	
Carbon	0.12 to 0.18 per cent
Silicon	not over 0.06 per cent
Manganese	not over 0.40 to 0.60 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.04 per cent

U-96. Weld Metal. The term *weld metal* as used in this code shall mean the metal of which the welded seam is composed after welding is completed, and which is described as being the metal deposited between the edges and for the purpose of joining the sections of the base metal. This metal may be, and usually is, a combination of base metal and filling metal, modified in the process of fusing.

U-97. Material for Base Metal. The base metal shall not exceed 5/8 in. thickness and shall be made by the open-hearth process, of soft and good weldable quality, and shall conform to the following requirements:

Chemical Properties and Tests

U-98. Chemical Composition:

Carbon	not over 0.15 per cent
Manganese	not over 0.60 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.05 per cent

The silicon, nickel, or chromium content shall not be of such amount as will affect adversely the welding qualities of the plate, and in any event shall not exceed 0.05 per cent.

U-99. Ladle Analysis. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus, and sulphur. This analysis shall be made from a test ingot taken during the pour of the melt. The chemical composition thus determined shall be reported to the purchaser, or his representative, and shall conform to the requirements specified in U-98.

Physical Properties and Tests

U-100. Tension Tests. *a* The base metal shall conform to the following requirements:

Tensile strength, max., lb. per sq. in.	55,000
Yield point, min., lb. per sq. in.	24,000
Elongation in 8 in., min., per cent	$\frac{1,500,000}{\text{Ten. Str.}}$

b The yield point shall be determined by the drop of the beam of the testing machine at a speed not exceeding $^1/_2$ in. per minute.

U-101. Test Specimens, Bend Tests, Finish, Etc. The test specimens, bend tests, homogeneity tests, number of tests, permissible variation in gage, finish, marking, inspection, rejection, shall conform with the requirements of the Specifications for Boiler Plate Steel.

U-102. Method of Welding. Seams, or joints may be welded on both sides by the double-V method, so-called, or on one side only with a single-V, using the butt-strap method in which the butt strap is tacked clear of the sheet at least $^1/_{16}$ in., or by such other method as will best assure the joint being filled with sound metal thoroughly fused, and to a thickness in excess of the maximum thickness of the plate, not less than 10 per cent, nor more than 15 per cent, see Fig. U-3, (*a*).

There shall be no valley either at the edge or in the center of the joint and the weld shall be so built up that the welded metal will present a gradual increase in thickness from the surface of the sheet to the center of the weld. At no point shall the sheet on one side of the joint be offset with the sheet on the other side of the joint in excess of one-quarter of the minimum thickness of the sheets, or plates.

U-103. Longitudinal Joints. Where vessels are made up of two or more cylinders, the welded longitudinal joints of adjacent sections shall be 180 deg. apart.

U-104. Distortion. The cylinder, or barrel of a vessel shall be substantially circular at any section, and to meet this requirement shall be reheated, rerolled or reformed.

U-105. Dished Heads. Dished heads convex to the pressure shall have a skirt not less than 3 in. long and shall be inserted into the shell with a driving fit in excess of the full length of the skirt, welded to the shell with a V'ed weld, heated to the annealing point, the shell to be constricted on the end to a diameter not less than 1 in. smaller than the original diameter.

Dished heads concave to the pressure shall have a skirt not less than one-tenth the diameter of the shell but not less than 3 in. long, and shall be attached to the cylinder by a butt weld.

U-106. Hemi-Spherical Heads. Hemi-spherical heads concave to the pressure shall have a skirt not less than 1 in. long, and shall be attached to the cylinder by a butt weld.

U-107. Nozzles. Nozzles in heads or shells over 3 in. and not to exceed 8 in. nominal size, shall be of forged or rolled steel with a flared skirt. These nozzles shall have a forged, rolled or Van Stone flange for pipe connections. The method of welding shall be as shown at (*a*), Fig. U-3.

U-108. Nipples. Nipples or couplings over 2 in. and not to exceed 3 in. nominal pipe size, shall be inserted from the inside through the sheet or plate, shell or head to a flange or shoulder and welded thoroughly from the bottom of the V'ed shell plate and with a fillet, as shown at (*b*) and (*c*) in Fig. U-3. The thickness of the nipple or coupling wall and shoulder shall be not less than extra heavy pipe-size standard. Nipples of this type smaller than 3 in. may conform to this same construction.

Threaded nipples 3 in. nominal pipe size and under, may be made of extra heavy steel pipe or steel tubing with corresponding thickness of wall, inserted in a hole with V'ed edges in the shell or head, and welded full with a fillet as specified before in this paragraph and as shown at (*d*) and (*e*) in Fig. U-3. Threaded connections for pipes 3 in. and under may be made by using an extra heavy pipe-size coupling inserted in a hole with V'ed edges in the shell or head and welded full with a fillet as before specified for nipples of like size and shown at (*e*) in Fig. U-3. Threaded connections for pipes 3 in. and under may also be made by building up a boss of filling metal thoroughly fused to the plate or sheet, and then drilling and tapping through both boss and sheet; the outside diameter of the boss shall be not less than the outside diameter of the boss of an extra heavy cast fitting of like pipe size, all as shown at (*f*) in Fig. U-3. The height of the boss and tapping shall be such that when a nipple is screwed into place, the inner end of the nipple, which shall have the full number of threads, shall be at least flush with the inner surface of the plate or sheet.

U-109. Hydrostatic Tests. While subject to the hydrostatic pressure herein before specified, a thorough hammer or impact test shall be given. This impact test shall consist of striking the sheet

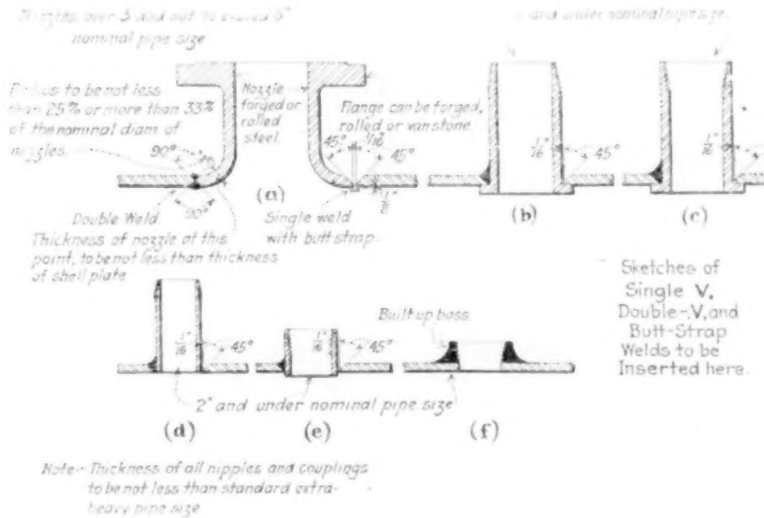


Fig. U-3 Methods of Autogenously Welding Nozzles

on both sides of the welded seam a sharp vibratory blow with a 2- to 6-lb. hammer with a handle similar to a blacksmith's striking hammer, the blows to be struck 2 to 3 in. apart and within 2 to 3 in. of, and on each side of, the seam—the blows to be as rapid as a man can conveniently strike a sharp, swinging blow, and as hard as can be struck without indenting or distorting the metal of the sheet. During this test the shell shall be completely filled with water.

U-110. Defective Welds. Welded seams, or joints, which do not pass this test without leaks, distortion or other signs of distress shall not be accepted until the defects are remedied and a further test applied which shall be successfully passed. Defective sections of a welded seam may be cut out and rewelded provided the value of the sheet has not been definitely lowered, and where this shall be brought into question a coupon shall be cut out across the weld at this point or points in question and subjected to microscopic or other examination.

RULES FOR FORGE WELDING

U-111. The plate for any part of a forge-welded vessel, on which welding is done, shall be of forge welding quality in accordance with the following specifications:

U-112. Process. The steel shall be made by the open-hearth process.

U-113. Chemical Composition. (*a*) The steel shall conform to the following requirements as to chemical composition:

Carbon	for plates $^3/_4$ in. or under in thickness...........	not over 0.18 per cent
	for plates over $^3/_4$ in. in thickness............	not over 0.20 per cent
Manganese.......................		40–0.60 per cent
Phosphorus......................		not over 0.04 per cent
Sulphur.........................		not over 0.05 per cent

(*b*) The composition of steel for forge welding plates should preferably be free from silicon, nickel or chromium. Where these elements are present the maximum quantity of any one shall not exceed 0.05 per cent.

U-114. Ladle Analysis. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus and sulphur. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in U-113.

U-115. Check Analysis. An analysis may be made by the purchaser from a broken tension test specimen representing each melt. The chemical composition thus determined shall conform to the requirements specified in U-113.

U-116. Tension Tests. *a* The material shall conform to the following requirements as to tensile properties:

Tensile strength, max., lb. per sq. in....	55,000
Yield point, min., lb. per sq. in.........	24,000
Elongation in 8 in., per cent........	$\frac{1{,}500{,}000}{\text{Tens. str.}}$

b The yield point shall be determined by the drop of the beam of the testing machine, at a speed not exceeding $^1/_2$ in. per minute.

U-117. Modifications in Elongation. *a* For material over $^3/_4$ in. in thickness, a deduction from percentage of elongation specified in U-116 (*a*) of 0.25 per cent shall be made for each increase of $^1/_{32}$ in. of the specified thickness above $^3/_4$ in., to a minimum of 20 per cent.

b For material under $^5/_{16}$ in. in thickness, a deduction from the percentage of elongation in 8 in. specified in U-116 (*a*) of 1.25 per cent shall be made for each decrease of $^1/_{32}$ in. of the specified thickness below $^5/_{16}$ in.

U-118. Bend Tests. The test specimen shall bend cold through 180 deg. flat on itself without cracking on the outside of the bent portion.

U-119. Test Specimens. *a* Test specimens shall be prepared for testing from the material in its rolled condition.

b Test specimens shall be taken longitudinally and except as specified in Par. (*c*) shall be of the full thickness of material as rolled. They may be machined to the form and dimensions shown in Fig. U-4, or with both edges parallel. (See Fig. 1, page 13, of Part I, Section 1, of the A.S.M.E. Boiler Code.)

c Test specimens for plates over $1^1/_2$ in. in thickness may be machined to a thickness or diameter of at least $^3/_4$ in. for a length of at least 9 in.

d The machined sides of rectangular bend test specimens may have the corners rounded to a radius not over $^1/_{16}$ in.

U-120. Number of Tests. *a* One tension and one bend test shall be made from each melt; except that if material from one melt differs $^3/_8$ in. or more in thickness, one tension and one bend test shall be made from both the thickest and the thinnest material rolled.

b If any test specimen shows defective machining or develops flaws it may be discarded and another specimen substituted.

c If the percentage of elongation of any tension test specimen is less than that specified in U-116 (*a*) and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

U-121. Finish. The finished material shall be free from injurious defects and shall have a workmanlike finish.

U-122. Marking. The name or brand of the manufacturer and the melt number shall be legibly rolled or stamped on all finished material. The melt number shall be legibly marked, by stamping if practicable, on each test specimen.

U-123. Inspection. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's work which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analysis) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

U-124. Rejection. *a* Unless otherwise specified, any rejection based on tests made in accordance with U-115 shall be reported within five working days from the receipt of samples.

b Material which shows injurious defects subsequent to its

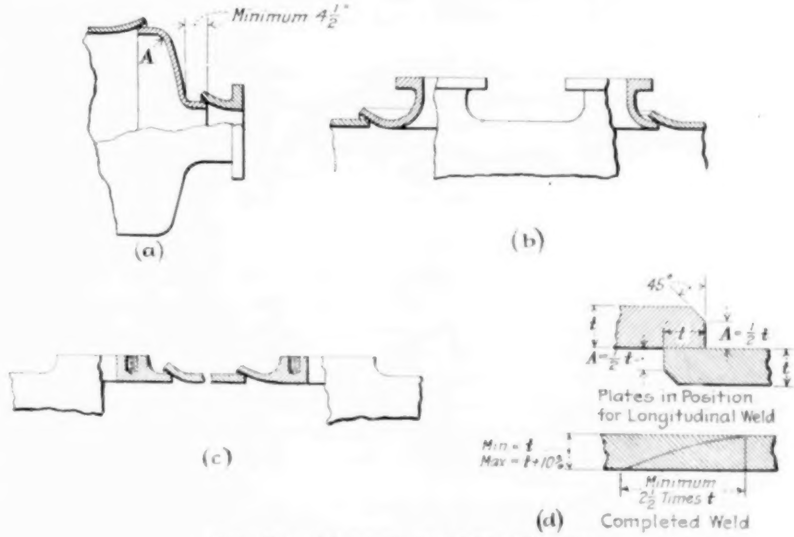


Fig. U-5 Methods of Forge Welding

acceptance at the manufacturer's works willl be rejected, and the manufacturer shall be notified.

U-125. Rehearing. Samples tested in accordance with U-115, which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for rehearing within that time.

U-126. The minimum thickness of any plate shall be $^1/_4$ in., but in no case shall the thickness of shell plate be less than the diameter of the vessel divided by 200.

U-127. The efficiency of the joint when properly welded by the forge welding process may be taken as 85 per cent of the minimum ultimate strength of the plate for Class A vessels and as 95 per cent for Class B vessels.

U-128. Corner Radius of Dished Heads. The corner radius of a dished head measured on the concave side of the head, shall be not less than 6 per cent of the inside diameter of the head [see *A* at (*a*), Fig. U-5].

U-129. Depth of Flange. The depth of flange on the flanged and dished head measured from a point tangent to the corner radius of the head to the end of the flange, shall be not less than 5 in.

U-130. Heating. The heating agent shall be suitably prepared water gas or other heating medium by which equivalent or superior results will be obtained, and shall be applied to both sides of the section and adjacent surfaces, and precaution shall be taken to see that the flame is of a type that will minimize the possibility of burning or oxidizing the metal and that it be free from all impurities which would tend to introduce foreign elements into the steel. The temperature of the flame for heating the surfaces shall be under constant and close control.

U-131. Welding. The edges that are to be welded together shall be lapped a distance at least equal to the thickness of the plate to be welded. All plates 1 in. thick and under shall be welded without scarfing; plates more than 1 in. thick, if desired by the manufacturer, may be scarfed, the scarf to start at least one-half

the thickness of the plate from the side next to the weld [see A at (d), Fig. U-5]. After the material has been brought up to the proper welding temperature, it shall be placed between an anvil and a hammer, or between rolls, or mandrel and roll, or between mandrels, and the plates welded together by a pressure, applied by the hammer or rolls, or mandrels, which will actually displace the material while the welding action is occurring. The metal in and adjacent to the weld shall not be worked at what is termed the critical blue heat temperature of the steel, that is, between about 400 and 800 deg. fahr.

The thickness of the weld for all longitudinal and circumferential seams or special welds [see (d), Fig. U-5] shall be as follows:

$$\text{Minimum} = t$$
$$\text{Maximum} = t \text{ plus } 10 \text{ per cent}$$

The contact line of completed forge weld shall be equal to at least two and one-half times the thickness of the plate (t) as shown at (d), Fig. U-5.

U-132. Annealing. All longitudinal and circumferential welds shall be annealed by heating to the proper temperature to relieve strains and then allowed to cool slowly. All longitudinal welds on cylindrical vessels shall be heated not less than 8 in. each side of the center of the weld or the entire shell, after which they shall be rerolled to a commercially true cylindrical form. If any vessel has been distorted out of shape it must be reformed and then annealed or reformed at a proper annealing temperature. In a finished cylindrical shell the variations in diameters shall not exceed 1 per cent of the mean outside diameter when measured at any section. When a straight edge two diameters long is laid longitudinally on the outside of a shell, it shall be possible to so set the straight edges that no part of the edge will come farther than 1 per cent of the mean outside diameter from the outer surfaces of the shell.

U-133. Inlet and Outlet Connections. All connections less than 5 in. standard pipe size may be attached by autogenous welding as specified in the code for autogenous welding. Nozzles 5 in. and over shall be attached by forge welding or by riveting.

If nozzles are attached by forge welding, they shall be of forge or rolled steel material, seamless tubing, or forge-welded pipe, attached to shell by forge welding, by either of the two methods shown at (b), Fig. U-5 or attached to a bead by forge-welding as shown at (a), Fig. U-5. Either the nozzle or shell may be flared for this purpose.

Saddle flanges may be used if made of forged steel and may be attached by forge welding or riveting by either of the two methods shown at (c), Fig. U-5.

All dished heads may be attached to shell by forge welding as shown at (a), Fig. U-5, or by riveting. (Note corner radius A referred to in Par. U-128).

U-134. Hydrostatic Tests. Vessels with seams or joints made by the forge welded process shall be subjected to the test specified in Par. U-109.

U-135. Every vessel with forge welded joints shall be inspected during its entire construction at the shop where manufactured. In the case of Class A vessels, the inspection and stamping shall be as provided in Pars. U-53 and U-54.

RULES FOR BRAZING

U-136. Steel plates for any part of a brazed vessel shall be made by the open-hearth process and shall not exceed $^5/_8$ in. in thickness. Plates $^1/_4$ in. thick or heavier may be of either flange or firebox quality as provided for in the Specifications for Boiler Plate Steel.

Chemical Properties and Tests

U-137. Sheets lighter than $^1/_4$ in. shall have the following properties:

U-138. Chemical Composition.

Carbon	not over 0.24 per cent
Manganese	not over 0.60 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.05 per cent

U-139. Ladle Analysis. An analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt, a copy of which shall be given to the purchaser or his representative. This analysis shall conform to the specifications given above.

U-140. Check Analysis. An analysis may be made by the purchaser from a broken tension test specimen which shall conform substantially to the requirements specified above.

Physical Properties and Tests

U-141. Tension Tests. The material shall conform to the following requirements as to tensile properties:

Tensile strength, max., lb. per sq. in.	70,000
Yield point, min., lb. per sq. in.	28,000
Elongation in 8 in., min., per cent	$\frac{1{,}500{,}000}{\text{Ten. Str.}}$

except that this may be reduced by $2^1/_2$ per cent for each $^1/_{16}$ in. under $^5/_{16}$ in.

U-142. Bend Test. The bend-test specimen shall bend cold through 180 deg. without cracking on the outside of the bent portion when bent around a pin the diameter of which is equal to the thickness of the specimen.

U-143. Number of Tests. Two tension tests and two bend tests shall be taken from each heat, but not both tension or both bend tests from the same slab.

U-144. Sheets less than $^1/_4$ in. in thickness shall not be required to be stamped at the mill on account of the small size and light weight of the sheets. The manufacturer must mark each tank in some permanent manner which will enable him to identify the heat from which the sheet in each tank has been rolled.

U-145. When the safety of the structure does not depend upon riveting in the joints, rivet holes may be punched full size.

U-146. For threaded openings, if the thickness of material in the pressure vessel is not sufficient to give the number of threads specified in U-48, the openings may be reinforced by a plate brazed to the shell, or have a boss built up by the welding process.

U-147. The strength of the joint when properly brazed may be taken as 95 per cent of the minimum ultimate strength of the plate.

U-148. Longitudinal seams shall have the edges of the plate lapped a distance of not less than eight times the thickness of the metal. The lap shall be held closely in position substantially metal to metal, by stitch riveting or other sufficient means. The brazing shall be done by placing the flux and brazing material on one side of the joint and applying heat until this material comes entirely through the lap and shows uniformly along the seam on the other side. Sufficient flux must be used to cause the brazing material to so appear promptly after reaching the brazing temperature. The brazing material used shall be such as to give a joint having a shearing strength of at least 10,000 lb. per sq. in.

U-149. Head Seams. Heads shall be driven into the shells with a tight driving fit, and shall be thoroughly brazed in approximately the same manner as the longitudinal seam for a depth or distance from the end of the shell equal to at least four times the thickness of the shell metal.

U-150. Vessels with seams or joints made by the brazing process shall be subjected to the test specified in Par. U-109.

U-151. If it is desired to stamp vessels with brazed joints, in order to indicate that they have been constructed in accordance with this Code, the provisions of Pars. U-53 and U-54 for Class A vessels, or of Pars. U-70 and U-71 for Class B vessels must be followed using the proper class letter in the authorized stamping.

Boiler plate, unless it is of the very best material, is often the cause of many troubles in the welding of the tubes into the sheet. The very method of making the plate tends to poor and non-uniform structure unless strict instructions are given as to the cropping, and are followed out. The impurities that go to the central part of the ingot will form flaws that will untimately find their way into the weld and in time result in leaks and fractures.

In determining the best method of welding the tubes into the tube sheet, consideration is given to three things: (1) the effect of the welding on the metal of both the tube and the tube sheet; (2) the effect of the final outline of the tube end, the tube sheet and the deposited metal, upon the hot gases entering the tube; (3) the amount of work required to perform the entire operation from start to finish. (*Power*, October 10, 1922, p. 558.)

Revision of Heating Boiler Section of A.S.M.E. Boiler Code, 1922

A HEARING is held by the Boiler Code Committee at least once in four years, at which all interested parties may be heard, in order that such revisions may be made as are found to be desirable, as the state of the art advances. The year 1922 becomes the period of the second revision, the first revised edition of the Boiler Code having been issued in 1918. The Boiler Code Committee plans to hold a Public Hearing in connection with the next Annual Meeting of the Society in December, 1922, to which the membership of the Society and everyone interested in the steam-boiler industry will be invited and where they may present their views.

In the course of the Boiler Code Committee's work during the past four years, many suggestions have been received for revisions of the Heating Boiler Section of the Code, as a result of the interpretations issued. In order that due consideration might be accorded to these recommendations, the Committee began in the early part of 1921 to devote special consideration to the proposed revisions. As a result of this many of the recommendations have been accepted and revisions of the paragraphs formulated.

These revisions in the rules are here published and it is the request that they be fully and freely discussed so that it may be possible for any one to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

Preliminary Report on Rules for the Construction of Boilers used Exclusively for Low-Pressure Steam Heating, Hot-Water Heating, and Hot-Water Supply

These rules are divided into two sections: Section 1 applying to steel-plate boilers, and Section 2 applying to cast-iron boilers. They do not apply to economizers or feedwater heaters.

SECTION 1—STEEL-PLATE BOILERS

H-1. These rules for steel-plate boilers shall apply:

a To all steam boilers for operation at pressures not exceeding 15 lb. per sq. in.

b To steel-plate hot-water boilers not exceeding 60 in. in diameter, or 160 lb. working pressure, or temperatures not exceeding 250 deg. fahr.

c For conditions exceeding those specified above, the rules for power boilers shall apply.

H-2. Wherever the term maximum allowable working pressure is used herein, it refers to gage pressure or the pressure above the atmosphere in pounds per square inch.

H-3. The maximum allowable working pressure shall not exceed 15 lb. per sq. in. on a steel-plate boiler built under these rules to be used for low-pressure steam heating.

The maximum allowable working temperature at or near the outlet of a hot-water steel-plate boiler shall not exceed 250 deg. fahr., or the maximum allowable working pressure 160 lb. per sq. in.

H-4. All steel-plate steam-heating and hot-water boilers shall be designed for a factor of safety of not less than 5, but in no case shall the pressure on which the factor of safety is based be considered less than 30 lb.

Materials

H-5. Specifications are given in the Rules for Power Boilers, Pars. 23–178, for the important materials used in the construction of boilers, and where so given the materials herein mentioned for boiler parts required to resist internal pressure shall conform thereto except as specified herein for autogenously welded boilers.

H-6. Steel plates for any part of a boiler where under pressure, also manhole and handhole covers and other parts subjected to pressure, and braces and lugs when made of steel plate, shall be of firebox or flange quality as designated in the Specifications for Boiler-Plate Steel, except for base metal as specified for autogenous welding.

H-7. Braces when made of parts welded together shall be of wrought iron of the quality designated in the Specifications for Refined Wrought-Iron Bars.

Ultimate Strength of Material

H-8. Tensile Strength of Steel Plate. In determining the maximum allowable working pressure, the tensile strength used in the computations for steel plates shall be that stamped on the plates as herein provided, which is the minimum of the stipulated range, or 55,000 lb. per sq. in. for all steel plates except for special grades having a lower tensile strength.

H-9. Crushing Strength of Steel Plate. The resistance to crushing of steel plate shall be taken at 95,000 lb. per sq. in. of cross-sectional area.

H-10. Strength of Rivets in Shear. In computing the ultimate strength of rivets in shear, the following values in pounds per square inch of the cross-sectional area of the rivet shank shall be used:

Iron rivets in single shear	38,000
Iron rivets in double shear	76,000
Steel rivets in single shear	44,000
Steel rivets in double shear	88,000

The cross-sectional area used in the computations shall be that of the rivet shank after driving.

Minimum Thickness of Plates and Tubes

H-11. The minimum thickness of any boiler plate under pressure shall be 1/4 in.

H-12. The minimum thickness of shell plates, heads and tube sheets for various shell diameters of steel-plate heating boilers shall be as shown in Table H-1.

TABLE H-1 MINIMUM ALLOWABLE THICKNESS OF SHELL PLATES

Diameter of Shell, Tube Sheet or Head	Minimum Thickness Allowable under Rules: Shell, in.	Tube Sheet or Head, in.
42 in. or under	1/4	5/16
Over 42 in. to 60 in.	5/16	3/8
Over 60 in. to 78 in.	3/8	7/16
Over 78 in.	7/16	1/2

H-13. The minimum thickness of butt straps for double-strap joints shall be as given in Table H-2. For plate thickness exceeding 3/4 in., the thickness of butt straps shall be not less than two-thirds of the thickness of the plate.

TABLE H-2 MINIMUM THICKNESS OF BUTT STRAPS

Thickness of Shell Plates, in.	Minimum Thickness of Butt Straps, in.
1/4	1/4
9/32	1/4
5/16	1/4
11/32	1/4
3/8	5/16
13/32	5/16
7/16	3/8
15/32	3/8
1/2	7/16
17/32	7/16
9/16	7/16
5/8	1/2
3/4	1/2

H-14. The minimum thickness of tubes used in water-tube or fire-tube boilers measured by Birmingham wire gage, shall be as given in Table H-3.

TABLE H-3 TUBES FOR WATER-TUBE AND FIRE-TUBE BOILERS

	Minimum Thickness of Tubes
Diameters 1 in. or over but less than 2 1/2 in.	No. 13 B.W.G.
Diameters 2 1/2 in. or over but less than 3 1/4 in.	No. 12 B.W.G.
Diameters 3 1/4 in. or over but less than 4 in.	No. 11 B.W.G.
Diameters 4 in. or over but less than 5 in.	No. 10 B.W.G.
Diameters 5 in.	No. 9 B.W.G.

Joints

H-15. Efficiency of a Joint. The efficiency of a joint is the ratio which the strength of the joint bears to the strength of the solid plate.

H-16. Riveted Boiler Joints. Longitudinal lap-riveted joints

will be allowed on all boilers when the diameter of the boiler shell does not exceed 60 in. (Welded boiler joints—See Pars. H-71 to H-83). If the boiler is to be operated at a working pressure above 30 lb., the rivets must be driven in holes drilled full size or in holes punched not to exceed $^1/_4$ in. less than full diameter and then drilled or reamed to full diameter; also, every portion of the sheared surfaces of the calking edges of plates, butt straps and heads shall be planed, milled or chipped to a depth of not less than $^1/_8$ in.

H-17. A horizontal-return-tubular boiler used for steam or hot water shall not have lap-riveted longitudinal joints over 12 ft. in length.

H-18. With butt-and-double-strap construction, longitudinal joints of any length may be used.

H-19. The longitudinal joints of horizontal-return-tubular boilers shall be located above the fire line of the setting.

H-20. The ends of shell plates forming the longitudinal joints in either autogenously welded boilers or riveted boilers, and butt straps, shall be formed by pressure, not blows, to the proper curvature.

Braced and Stayed Surfaces

H-21. The maximum allowable working pressure for various thicknesses of braced and stayed flat plates and those which by these Rules require staying as flat surfaces with braces or staybolts of uniform diameter symmetrically spaced, shall be calculated by the formula:

$$P = C \times \frac{T^2}{p^2}$$

where P = maximum calculated allowable working pressure, lb. per sq. in. (not less than 30 lb.)

T = thickness of plate in *sixteenths* of an inch

p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined, in.

C = 112 for stays screwed through plates not over $^7/_{16}$ in. thick with ends riveted over or for stays welded into such plates

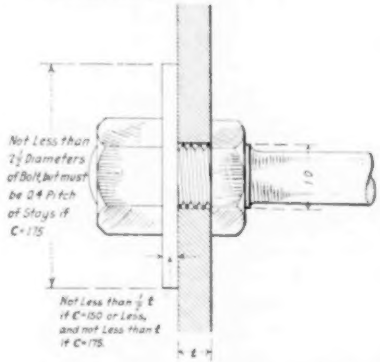


FIG. H-1 ACCEPTABLE PROPORTIONS FOR ENDS OF THROUGH STAYS

C = 120 for stays screwed through plates over $^7/_{16}$ in. thick with ends riveted over or for stays welded into such plates

C = 135 for stays screwed through plates and fitted with single nuts outside of plate

C = 150 for stays with heads not less than 1.3 times the diameter of the stays, screwed through plates or made a taper fit and having the heads formed on the stays before installing them and not riveted over, said heads being made to have a true bearing on the plate

C = 175 for stays fitted with inside and outside nuts and outside washers where the diameter of washers is not less than $0.4p$ and thickness not less than T.

If a flat boiler plate not less than $^3/_8$ in. thick is strengthened with a doubling plate covering the full area of the stayed surface and securely riveted thereto and having a thickness of not less than $^2/_3\,T$, then the value of T in the formula shall be three-quarters of the combined thickness of the boiler plate and doubling plate but not more than one and one-half times the thickness of the boiler plate, and the value of C given above may also be increased 15 per cent.

When two sheets are connected by stays and but one of these sheets requires staying, the value of C is governed by the thickness of the sheet requiring staying.

Acceptable proportions for the ends of through stays with washers are indicated in Fig. H-1.

H-22. Stays. The ends of stays fitted with nuts shall not be exposed to the direct radiant heat of the fire.

H-23. The diameter of a screw stay shall be taken at the bottom of the thread, provided this is the least diameter. No screwed stay or stay welded in by the autogenous process shall be made of stock less than $^3/_4$ in. diameter.

H-24. Area of Heads to be Stayed. The area of a segment of a flanged head to be stayed shall be the area enclosed by lines drawn 2 in. from the tubes and 3 in. from the shell.

H-25. When the portion of the head below the tubes in a horizontal-return-tubular boiler is provided with a manhole opening, the flange of which is formed from the solid plate and turned inward to a depth of not less than three times the required thickness of the head, measured from the outside, the area to be stayed as indicated in Fig. H-2, may be reduced by 100 sq. in. The surface around the manhole shall be supported by through stays with nuts inside and outside at the front head.

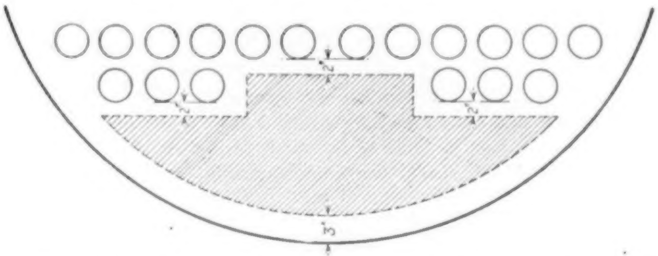


FIG. H-2 METHOD OF DETERMINING NET AREA OF IRREGULAR SEGMENT OF A HEAD

The distance in the clear between the bodies of the braces, or of the inside braces where more than two are used, shall not be less than 10 in. at any point.

H-26. The maximum allowable stress per square inch at point of least net cross-sectional area of stays and staybolts shall be as given in Table H-4. In determining the net cross-sectional area of drilled or hollow staybolts, the cross-sectional area of the hole shall be deducted.

TABLE H-4 MAXIMUM ALLOWABLE STRESSES FOR STAYS AND STAYBOLTS

Description of Stays	Stresses, Lb. per Sq. In. — For lengths between supports not exceeding 120 diameters	Stresses, Lb. per Sq. In. — For lengths between supports exceeding 120 diameters
a Unwelded or flexible stays less than 20 diameters long, screwed through plates with ends riveted over, or such stays welded in by the autogenous process	7,500	....
b Hollow steel stays less than 20 diameters long, screwed through plates with ends riveted over, or such stays welded in by the autogenous process	8,000	....
c Unwelded stays and unwelded portions of welded stays, except as specified in line *a* and *b*	9,500	8,500
d Steel through stays exceeding $1^1/_2$ in. diameter	10,400	9,000
e Welded portions of stays	6,000	6,000

Boiler Openings

H-27. All boilers shall be provided with suitable manhole openings and handhole or washout-plug openings to permit inspection and to permit removal of any sediment which may accumulate. Where the size of construction is such that entrance is impractical, manhole openings may be omitted.

H-28. A manhole shall be placed in the front head below the tubes of a horizontal-return-tubular boiler 48 in. or over in diameter. There shall be a manhole in the upper part of shell or head of a fire-tube boiler over 48 in. in diameter, except a vertical fire-tube boiler, or except a boiler used exclusively for hot-water heating where there is no steam space.

A boiler of the locomotive or firebox type shall have one handhole

or washout plug near each corner in the lower part of the water leg and at least one opening near the line of the crown sheet.

Vertical fire-tube or similar-type boilers shall have at least three handholes or washout plugs in the lower part of the water leg and at least two handholes or washout plugs near the line of the lower tube sheet.

H-29. Washout plugs shall have threads of non-ferrous material and shall not be less than $1^1/_2$ in. pipe size.

Washout openings may be used for return pipe connections and the washout plug placed in a tee so that the plug is directly opposite and as close as possible to the opening in the boiler.

H-30. Threaded Openings. All threaded openings in a boiler shall be tapped into material having a minimum thickness as specified for the various standard pipe sizes in Table H-5.

TABLE H-5 MINIMUM THICKNESS OF MATERIAL FOR TAPPINGS

Pipe Size, In.	Minimum Thickness of Material or Length of Thread Required, In.
1 and under	$^1/_4$
$1^1/_4$ to 2 inclusive	$^5/_{16}$
$2^1/_2$	$^7/_{16}$
3 to $3^1/_2$ inclusive	$^5/_8$
4 to 5 inclusive	$^7/_8$
6 to 8 inclusive	1
9 to 12 inclusive	$1^1/_4$

H-31. Flanged Connections. Openings in boilers having flanged connections shall have the flanges conform to the American Standard given in Tables 16 or 17 of the Appendix, for the corresponding pipe size, and shall have the corresponding drilling for bolts or studs.

Supports

H-32. A horizontal-return-tubular boiler over 78 in. in diameter shall be supported from steel lugs by the outside suspension type of setting, independent of the boiler side walls. The lugs shall be so designed that the load is properly distributed between the rivets attaching them to the shell and so that no more than two of these rivets come in the same longitudinal line on each lug. The distance girthwise of the boiler from the centers of the bottom rivets to the centers of the top rivets attaching the lugs shall be not less than 12 in. The other rivets used shall be spaced evenly between these points. If more than four lugs are used they shall be set in four pairs.

H-33. A horizontal-return-tubular boiler over 54 in. and up to and including 78 in. in diameter, shall be supported by the outside suspension type of setting, or at four points by not less than eight steel or cast-iron brackets, set in pairs. A horizontal-return-tubular boiler up to and including 54 in. in diameter shall be supported by the outside suspension type of setting, or by not less than two steel or cast-iron brackets on each side.

H-34. Lugs or brackets, when used to support a boiler of any type shall be properly fitted to the surfaces to which they are attached. The shearing and crushing stresses on the rivets used for attaching the lugs or brackets shall not exceed 8 per cent of the strength given in Pars. H-9 and H-10. Where it is impractical to use rivets, studs with not less than ten threads per inch may be used. In computing the shearing stress, the area at the bottom of the thread shall be used.

Setting and Installation

H-35. Wet-bottom steel-plate boilers shall have a space of not less than 12 in. between the bottom of the boiler and the floor line with access for inspection.

H-36. The minimum size of access door used in boiler setting shall be 12 in. by 16 in. or equivalent area, the least dimensions being 11 in.

H-37. Provisions shall be made for the expansion and contraction of steam mains connected to boilers, by providing substantial anchorage at suitable points, so that there shall be no undue strain transmitted to the boiler.

H-38. Feed or make-up water shall not be discharged directly into any part of a boiler exposed to the direct radiant heat from the fire.

H-39. All hot-water heating systems shall be so installed that there will be no opportunity for the fluid-relief column to freeze or to be accidentally shut off.

H-40. If valves are used in the supply and return mains they shall be locked and sealed open and bear tags stating that provision must be made to prevent pressure from building up in the boiler whenever the valves are closed. It is recommended that no valves be placed in the supply and return mains of single boiler installations.

H-41. When a valve is placed in the top connection from a hot-water supply boiler to a storage tank, an additional connection without valve shall be made between the boiler and top of storage tank.

Fittings and Appliances

H-42. Connections for Safety and Water-Relief Valves. Every boiler shall have proper outlet connections for the required safety or water-relief valves, independent of any other connection outside of the boiler. A steam equalizing pipe between boilers is not to be considered as a connection outside of the boiler in applying the requirements of this paragraph. The area of the opening is to be at least equal to the aggregate area based on the nominal diameters of all of the safety valves with which it connects. A screwed connection may be used for attaching a safety valve.

H-43. Safety Valves. Each steam boiler shall be provided with one or more safety valves of the spring pop type adjusted and sealed to discharge at a pressure not to exceed 15 lb. per sq. in. No safety valve for a steam boiler shall be smaller than $^3/_4$ in., except in case the boiler and radiating surfaces are self-contained. No safety valve shall be larger than $4^1/_2$ in.

H-44. Water-Relief Valves. Water-relief valves shall be connected to all hot-water boilers. The valve shall be of the diaphragm-operating type set to open at or below the maximum allowable working pressure. No water-relief valve shall be smaller than $^1/_2$ in. nor greater than 2 in. standard pipe size. The outlets of water-relief valves shall have open discharges in plain sight.

H-45. When two or more safety or water-relief valves are used on a boiler, they may be single, twin, or duplex valves.

H-46. Safety or water-relief valves shall be connected to the boilers independent of other connections and be attached directly or as close as possible to the boiler without any unnecessary intervening pipe or fitting except the Y-base forming a part of the twin valve or a steam equalizing pipe between boilers. A safety valve or water-relief valve shall not be connected to an internal pipe in the boiler. Safety valves or water-relief valves shall be connected so as to stand upright with the spindle vertical when possible.

H-47. No shut off of any description shall be placed between the safety or water-relief valve and boiler, nor on discharge pipes between such valves and the atmosphere.

H-48. When a discharge pipe is used its area shall be not less than the area of the valve or aggregate area based on the nominal diameters of the valves with which it connects, and the discharge pipe shall be fitted with an open drain to prevent water from lodging in the upper part of the valve or in the pipe. When an elbow is placed on a safety or water-relief valve discharge pipe, it shall be located close to the valve outlet or the pipe shall be securely anchored and supported. The safety or water-relief valves shall be so located and piped that there will be no danger of scalding attendants.

H-49. Each safety valve, $^3/_4$ in. or over, used on a steam-heating boiler, shall have a substantial lifting device by which the valve may be raised from its seat at least $^1/_{16}$ in. when there is no pressure on the boiler.

H-50. A relief valve used on a hot-water boiler need not have a lifting device.

H-51. Every safety valve or water-relief valve shall have plainly stamped on the body or cast thereon the letters A.S.M.E. STD., in such a way that the markings cannot be obliterated in service, the manufacturer's name or trademark and the pressure at which it is set to blow, and in addition, the safety valve shall be marked with the pounds of steam discharged per hour while blowing at $33^1/_3$ per cent overpressure when set to relieve at 15 lb. per sq. in. The seats and disks of safety or water-relief valves shall be made of non-ferrous material.

H-52. The diameter of seat shall determine the nominal diameter of safety or water-relief valve as given in Tables H-6 or H-7. The pipe thread at the inlet shall not be less than the nominal valve size.

H-53. The minimum size of safety or water-relief valve or valves

for each boiler shall be governed by the rated capacity of the boiler as shown by Tables H-6 or H-7.

The safety-valve capacity for each steam boiler shall be such that the safety valve or valves will discharge all the steam that can be generated by the boiler without allowing the pressure to rise more than 5 lb. above the maximum allowable working pressure of the boiler.

When the size of boiler exceeds the values given in Tables H-6 or H-7, safety valves or water-relief valves whose combined capacities equal the rated capacity of the boiler shall be selected from the tables.

TABLE H-6 MINIMUM ALLOWABLE SIZES OF SAFETY VALVES FOR STEAM HEATING BOILERS

Safety Valve			Rated Capacity of Boiler	
Diameter, In.	Area, Sq. in.	Discharge Capacity, Lb. per Hr.[1]	Steam Radiation, Sq. ft.	Steam, Lb. per Hr.
$^1/_4$	0.0491	15	60	15
$^3/_8$	0.1104	30	120	30
$^1/_2$	0.1963	60	240	60
$^3/_4$	0.4418	130	520	130
1	0.7854	230	920	230
$1^1/_4$	1.2272	360	1440	360
$1^1/_2$	1.7671	515	2065	515
2	3.1416	920	3680	920
$2^1/_2$	4.9087	1435	5740	1435
3	7.0686	2070	8280	2070
$3^1/_2$	9.6211	2810	11250	2810
4	12.5660	3675	14700	3675
$4^1/_2$	15.9040	4650	18600	4650

[1] Capacity of safety valve based on $33^1/_3$ per cent overpressure, valve set to relieve at 15 lb. per sq. in.

Note: For the purpose of these computations 240 heat units or 0.25 lb. of steam per hour shall be considered as the equivalent of a square foot of steam radiation.

TABLE H-7 MINIMUM ALLOWABLE SIZES OF WATER RELIEF VALVES FOR WATER-HEATING BOILERS AND FOR WATER-SUPPLY BOILERS

Diameter of Valve, In.	Rated Capacity in Sq. ft. Water Radiation	Rated Capacity in Gallons per Hour 25° rise	50° rise	100° rise
$^1/_2$	750	540	270	135
$^3/_4$	2000	1440	720	360
1	3500	2520	1260	630
$1^1/_4$	7500	5400	2700	1350
$1^1/_2$	15000	10800	5400	2700
2	30000	21600	10800	5400

Note: For the purpose of these computations 150 heat units per hour shall be considered as the equivalent of a square foot of water radiation.

H-54. When a hot-water supply is heated indirectly, by steam in a coil or pipe, the pressure of the steam used shall not exceed the safe working pressure of the hot-water tank, and a water-relief valve of at least 1 in. in diameter, set to relieve at or below the maximum allowable working pressure of the tank, shall be used.

H-55. Steam Gages. Each steam boiler shall have a steam gage connected to the steam space or to the water column, or its steam connection, by means of a siphon or equivalent device of sufficient capacity to keep the gage tube filled with water and so arranged that the gage cannot be shut off from the boiler except by a cock placed near the gage and provided with a tee or lever handle arranged to be parallel with the pipe in which it is located when the cock is open. Pipe connections to steam gages smaller than 1 in. pipe size shall be of brass, copper, or bronze composition when the distance between the gage and point of attachment of pipe is over 5 ft. If less than 5 ft., the connections shall be of brass, copper, or bronze composition if smaller than $^1/_2$ in. pipe size. The dial of a steam gage for a steam heating boiler shall be graduated to not less than 30 lb., and shall be provided with a stop pin at the zero and maximum points and the graduations shall not occupy more than 325 degrees of the dial circumference.

H-56. Pressure or Altitude Gages. Each hot-water boiler shall have a gage connected in such a manner that it cannot be shut off from the boiler except by a cock with tee or lever handle, placed on the pipe near the gage. The handle of the cock shall be parallel to the pipe in which it is located when the cock is open. Pipe connections to gages smaller than 1 in. pipe size shall be made of brass, copper, or bronze composition when the distance between the gage and point of attachment of pipe is over 5 ft. If less than 5 ft., the connections shall be of brass, copper, or bronze composition if smaller than $^1/_2$ in. pipe size. The dial of the pressure or altitude gage shall be graduated to not less than $1^1/_2$ times the maximum allowable working pressure, and shall be provided with a stop pin at the zero and maximum points and the graduations shall not occupy more than 325 degrees of the dial circumference.

H-57. Thermometers. Each hot-water boiler shall have a thermometer so located and connected that it shall be easily readable when observing the water pressure or altitude. The thermometer shall be so located that it shall at all times indicate the temperature in degrees fahrenheit of the water in the boiler at or near the outlet.

H-58. Temperature Combustion Regulators. A temperature combustion regulator which will control the rate of combustion to prevent the temperature of the water from rising above 250 deg. fahr. at or near the outlet or an equivalent thermostatic relieving device, shall be used on all hot-water boilers.

H-59. Pressure Combustion Regulators. When a pressure combustion regulator is used, it shall operate to prevent the steam pressure from rising above 15 lb.

H-60. Bottom Blow-Off. Each boiler shall have a blow-off pipe connection fitted with a valve or cock not less than $^3/_4$-in. pipe size connected with the lowest water space practicable.

H-61. Water-Gage Glasses. Each steam boiler shall have at least one water-gage glass.

H-62. Gage Cocks. Each steam boiler shall have two or more gage cocks located within the range of the visible length of the water glass.

H-63. Water-Column Pipes. The minimum size of pipes connecting the water column of a steam boiler shall be 1 in. Water-glass fittings or gage cocks may be connected direct to the boiler. The steam connection to the water column of a horizontal-return-tubular boiler shall be taken from the top of the shell or the upper part of the head; the water connection shall be taken from a point not less than 6 in. below the center line of the shell. No connections, except for combustion regulator, drains or steam gages, shall be placed on the pipes connecting a water column to a boiler. If the water column or gage glass is connected to the boiler by pipe and fittings, crosses or tees shall be used on the water connection to facilitate cleaning.

H-64. Fusible Plugs. A fusible plug, if used, shall be placed at the lowest safe water line and in contact with the products of combustion.

Hydrostatic Test

H-65. All hot-water boilers, the maximum allowable working pressure of which is not in excess of 30 lb. per sq. in., and steam-heating boilers, shall be subjected to a hydrostatic test of 60 lb. per sq. in., both at the shop where constructed and in the field when erected and ready for service. Hot-water boilers, the maximum allowable working pressure of which exceeds 30 lb. per sq. in., shall be subjected to a hydrostatic test of $1^1/_2$ times the maximum allowable working pressure both at the shop where constructed and in the field when erected and ready for service.

Any hydrostatic pressure test to be made on either a steam-heating boiler or hot-water boiler, after the boiler has been in service, shall be at a pressure $1^1/_2$ times the maximum allowable working pressure.

In making hydrostatic pressure tests the pressure shall be under such control that in no case shall the required test pressure be exceeded by more than 6 per cent.

H-66. Individual shop inspection shall not be required for boilers which come under the rules of this section, except for boilers constructed by autogenous welding (see Par. H-81).

H-67. Each plate of a completed boiler shall bear the plate maker's name with brand and tensile strength, except that these marks need not appear on the butt straps after completion of boiler.

H-68. All boilers built according to these rules and no other boilers shall be marked A.S.M.E. Std.-Heat., and with the manufacturer's name and maximum allowable working pressure. These markings shall be stamped with letters and figures at least $^5/_{16}$ in. high on some conspicuous portion of the boiler proper, preferably over or near the fire door. Boilers suitable for use for both steam and water shall have the stamps arranged substantially as follows:

A.S.M.E. STD.-HEAT

....

(Manufacturer's Name)

Max. W. P., Steam 15 lb.
Water... lb.

Boilers suitable for use for water only shall have the stamps arranged substantially as follows:

A.S.M.E. STD.-HEAT
....
(Manufacturer's Name)
Max. W. P., Water.....lb.

These stamps shall not be covered with insulating or other material. The symbol authorized for use on power boilers shall not be used on heating boilers.

Autogenously Welded Boilers

H-69. Autogenous Welds. The autogenous welding process consists of welding by means of either the oxy-acetylene process or the electric arc process, using a metallic electrode, either bare, coated, or covered.

H-70. Steel-plate boilers constructed by autogenous welding under the rules prescribed for steel-plate heating boilers may be used for steam heating at pressures not exceeding 15 lb. per sq. in., or for hot-water heating at pressures not exceeding 160 lb. per sq. in. For pressures in excess of 30 lb. per sq. in. for hot-water boilers, the factor of safety for autogenously welded steel-plate boilers shall be not less than 5, assuming the strength of the welded seams at 50 per cent of the full strength of the plate at the welds.

H-71. Design and Construction. The design, construction, and stamping of autogenously welded boilers shall in all cases conform to the formulas, specifications and data which are given in the Rules prescribed for steel-plate heating boilers, unless some special requirement is necessary because of welding, in which case the requirements will be hereinafter detailed.

H-72. Base Metal. The term base metal when used, shall mean the metal or metals of which the boiler is constructed and which are joined together by the welded seam.

H-73. Filling Material. The term filling material shall mean the weld rod, filling rod, electrode or other metal which is used to join two sections of the base metal or metals. Either of the filling metals given in Table H-8 shall be used for oxy-acetylene or electric arc welding, respectively.

TABLE H-8 FILLING METAL FOR OXY-ACETYLENE OR ELECTRIC ARC WELDING

	Oxy-Acetylene Welding	Electric Arc Welding
Carbon	Not over 0.06 per cent	Not over 0.06 per cent
Silicon	Not over 0.08 per cent	Not over 0.08 per cent
Manganese	Not over 0.15 per cent	Not over 0.15 per cent
Phosphorus	Not over 0.04 per cent	Not over 0.04 per cent
Sulphur	Not over 0.04 per cent	Not over 0.04 per cent
Carbon	0.18 to 0.22 per cent	0.12 to 0.18 per cent
Manganese	0.40 to 0.50 per cent	Not over 0.06 per cent
Phosphorus	Not over 0.04 per cent	Not over 0.40 to 0.60 per cent
Sulphur	Not over 0.04 per cent	Not over 0.04 per cent
Nickel	3.0 to 3.5 per cent	Not over 0.04 per cent

The filling metal must be clean, flow freely, and shall neither "spit nor spark" appreciably during welding. Its fusing temperature shall be such as to correspond relatively with that of the sheet, or base metal. The size of the wire and the size of the tip shall be such as to enable the welder to meet the conditions required by the work he is doing with oxy-acetylene welding, and the size of the electrode and current characteristics should meet the same conditions for electric arc welding.

H-74. Material for Base Metal. The base metal composing the plates of autogenously welded steel-plate heating boilers shall be made by the open-hearth process of soft and good weldable quality and shall conform to the following requirements:

Chemical Composition by Ladle Test:

Carbon by combustion test	not over 0.15 per cent
Manganese	not over 0.60 per cent
Phosphorus	not over 0.05 per cent
Sulphur	not over 0.04 per cent

H-75. Analysis. A ladle analysis of each melt shall be made by the manufacturer to determine the percentage of the important elements, carbon, manganese, phosphorus, and sulphur. This analysis shall be made from a test ingot taken during the pour of the melt. The chemical composition thus determined shall be furnished the purchaser, or his representative, and shall conform to the requirements as specified.

H-76. Tension Tests. The base metal of autogenously welded steel-plate boilers shall conform to the following requirements:

Tensile strength in lb. per sq. in.	42,000-55,000
Yield point, lb. per sq. in. minimum	0.5 Ten. Str.
Elongation in 8 in., min., per cent	$\dfrac{1{,}500{,}000}{\text{Ten. Str.}}$

H-77. Test Specimens, Bend Tests, Finish, Etc. The test specimens, bend test, homogeneity test, number of test, permissible variation in gage, finish, marking, inspection, and rejection for material used in autogenously welded steel-plate boilers shall conform with the requirement of Par. H-5.

H-78. Method of Welding. Seams or joints on autogenously welded steel-plate boilers may be welded on both sides by the double-V method, socalled, or on one side only with a single-V or by using such methods as will assure a joint of sound metal thoroughly fused and to a thickness in excess of the maximum thickness of plate.

There shall be no valley either on the edge or in the center of the joint and the weld shall be so built up that the welded metal shall present a gradual increase in thickness from the surface of the sheet to the center of the weld. At no point shall the sheet on one side of the joint be offset with the sheet on the other side of the joint in excess of one quarter of the minimum thickness of the sheets or plates except where stayed plates are lap joined.

H-79. Longitudinal Joints. Where autogenously welded steel-plate heating boilers are made up of two or more courses, the welded longitudinal joints of adjacent courses shall be not less than 90 deg. apart.

H-80. Before welding longitudinal seams of cylindrical drums the plate shall be preheated along the full length of the edge to be welded to a substantially uniform temperature so as to show red in daylight for a width of about 3 in. on each side of the weld, and this temperature shall be maintained during the welding.

H-81. Every boiler, the unsupported joints of which are welded by the autogenous process, shall be inspected during its construction at the shop where manufactured, by a duly authorized inspector. The inspector shall examine the boiler at least three times during its construction; first, examining the material and the preparation for joining the parts if prepared before the parts are set up; second, the boiler shall be examined after the parts are set up and ready for welding; third, the completed boiler shall be examined and the final hydrostatic test witnessed. The inspector shall be a state inspector, municipal inspector or an inspector employed regularly by an insurance company which is authorized to do a boiler insurance business in the state in which the boiler is built and in the state in which it is to be used, if known.

H-82. Steel-plate boilers having cylindrical shells and constructed by autogenous welding shall have their shell length limited to four diameters and in no case to exceed 20 ft. in length.

H-83. Where staybolts are to be welded into stayed plates by the autogenous process the staybolt holes shall be countersunk to within at least $^1/_{16}$ in. of the full thickness of the plate. The base metal of the plate and staybolt shall be welded to the full thickness of the plate. The staybolts shall be of such length that they will project at least $^1/_8$ in. above the surface of the plate in which they are welded.

SECTION 2—CAST-IRON BOILERS

H-84. These Rules for cast-iron boilers shall apply:

a To all steam boilers for operation at pressures not exceeding 15 lb. per sq. in.

b To hot-water boilers to be operated at pressures not exceeding 160 lb. per sq. in., or temperatures not exceeding 250 deg. fahr.

c For conditions exceeding those specified above, cast-iron construction is not permitted.

H-85. Wherever the term maximum allowable working pressure is used herein, it refers to gage pressure or the pressure above the atmosphere in pounds per square inch.

H-86. The maximum allowable working pressure shall not ex-

ceed 15 lb. per sq. in. on a cast-iron boiler built under these rules to be used exclusively for low-pressure steam heating.

The maximum allowable working temperature at or near the outlet of a hot-water cast-iron boiler shall not exceed 250 deg. fahr.

Boiler Openings

H-87. Washout Openings. All cast-iron steam and hot-water boilers shall be provided with suitable washout openings to permit the removal of any sediment that may accumulate therein. Washout openings may be used for return pipe connections and the washout plug placed in a tee so that the plug is directly opposite and as close as possible to the opening in the boiler.

H-88. Flanged Connections. Flanged openings in boilers shall conform to the American Standard given in Tables 16 or 17 of the Appendix, for the corresponding pipe size, and shall have the corresponding drilling for bolts or studs.

H-89. Threaded Openings. Pipe connections if threaded shall be tapped into material having a minimum thickness as specified in Table H-9.

TABLE H-9 MINIMUM THICKNESS OF MATERIAL FOR THREADED CONNECTIONS TO BOILERS

Size of Pipe Connection, In.	Minimum Thickness of Material Required, In.
3/4 and under	5/16
1 to 2 1/2 inclusive	7/16
3 to 3 1/2 inclusive	5/8
4 to 5 inclusive	7/8
6 to 8 inclusive	1
9 to 12 inclusive	1 1/4

Installation

H-90. Provisions shall be made for the expansion and contraction of steam mains connected to boilers by providing substantial anchorage at suitable points, so that there shall be no undue strain transmitted to the boiler.

H-91. When feed or make-up water is introduced from a pressure line, it shall be connected to the piping system and not directly to the boiler.

H-92. All hot-water heating systems shall be so installed that there will be no opportunity for the fluid-relief column to freeze or to be accidentally shut off.

H-93. If valves are used in the supply and return mains, they shall be locked and sealed open and bear tags stating that provision must be made to prevent pressure from building up in boiler whenever the valves are closed. It is recommended that no valves be placed in the supply and return mains of a single boiler installation. Provision shall be made for cleaning the interior of the return main at or near the boiler.

H-94. When a valve is placed in the top connection from a hot-water supply boiler to a storage tank, an additional connection without valve shall be made between the boiler and top of storage tank.

H-95. Connections for Safety and Water-Relief Valves. Every boiler shall have proper outlet connections for the required safety or water-relief valves, independent of any other connection outside the boiler. A steam equalizing pipe between boilers is not to be considered as a connection outside of the boiler in applying the requirements of this paragraph. The area of the opening is to be at least equal to the aggregate area based on the nominal diameters of all of the safety valves with which it connects. A screwed connection may be used for attaching a safety valve.

Fittings and Appliances

H-96. Safety Valves. Each steam boiler shall be provided with one or more safety valves of the spring pop type adjusted and sealed to discharge at a pressure not to exceed 15 lb. per sq. in. No safety valve for a steam boiler shall be smaller than 3/4 in., except in case the boiler and radiating surfaces are assembled in a self-contained unit. No safety valve shall be larger than 4 1/2 in.

H-97. Water-Relief Valves. Water-relief valves shall be connected to all hot-water boilers. The valve shall be of the diaphragm-operating type set to open at or below the maximum allowable working pressure. No water-relief valve shall be smaller than 1/2 in. nor greater than 2 in. standard pipe size. The outlets of water-relief valves shall have open discharges in plain sight.

H-98. When two or more safety or water-relief valves are used on a boiler, they may be single, twin, or duplex valves.

H-99. Safety or water-relief valves shall be connected to the boilers independent of other connections and be attached directly or as close as possible to the boiler without any unnecessary intervening pipe or fitting except the Y-base forming a part of the twin valve or a steam equalizing pipe between boilers. A safety valve or water-relief valve shall not be connected to an internal pipe in the boiler. Safety valves or water-relief valves shall be connected so as to stand upright with the spindle vertical when possible.

H-100. No shut-off of any description shall be placed between the safety or water-relief valve and boiler nor on discharge pipes between such valves and the atmosphere.

H-101. When a discharge pipe is used its area shall be not less than the area of the valve or aggregate area based on the nominal diameters of the valves with which it connects, and the discharge pipe shall be fitted with an open drain to prevent water from lodging in the upper part of the valve or in the pipe. When an elbow is placed on a safety or water-relief valve discharge pipe, it shall be located close to the valve outlet or the pipe shall be securely anchored and supported. The safety or water-relief valves shall be so located and piped that there will be no danger of scalding attendants.

H-102. Each safety valve, 3/4 in. or over, used on a steam-heating boiler, shall have a substantial lifting device by which the valve may be raised from its seat at least 1/16 in. when there is no pressure on the boiler.

H-103. A relief valve used on a hot-water boiler need not have a lifting device.

H-104. Every safety valve or water-relief valve shall have plainly stamped on the body or cast thereon, the letters A.S.M.E. STD., in such a way that the marking will not be obliterated in service, the manufacturer's name or trade mark and the pressure at which it is set to blow; and in addition, the safety valve shall be marked with the pounds of steam discharged per hour while blowing at 33 1/3 per cent overpressure when set to relieve at 15 lb. per sq. in. The seats and disks of safety or water-relief valves shall be made of non-ferrous material.

H-105. The diameter of seat shall determine the nominal diameter of safety or water-relief valve as given in Tables H-10 or H-11. The pipe thread at the inlet shall not be less than the nominal valve size.

H-106. The minimum size of safety or water-relief valve or valves for each boiler shall be goverened by the rated capacity of the boiler as shown by Tables H-10 or H-11.

The safety valve capacity for each steam boiler shall be such that the safety valve or valves will discharge all the steam that can be generated by the boiler without allowing the pressure to rise more than 5 lb. above the maximum allowable working pressure of the boiler.

When the size of boiler exceeds the values given in Tables H-10 or H-11, safety valves or water-relief valves whose combined capacities equal the rated capacity of the boiler shall be selected from the tables.

TABLE H-10 MINIMUM ALLOWABLE SIZES OF SAFETY VALVES FOR STEAM-HEATING BOILERS

Safety Valve			Rated Capacity of Boiler	
Diameter, In.	Area, Sq. in.	Discharge Capacity, Lb. per Hr.[1]	Steam Radiation, Sq. ft.	Steam, Lb. per Hr.
1/4	0.0491	15	60	15
3/8	0.1104	30	120	30
1/2	0.1963	60	240	60
3/4	0.4418	130	520	130
1	0.7854	230	920	230
1 1/4	1.2272	360	1440	360
1 1/2	1.7671	515	2065	515
2	3.1416	920	3680	920
2 1/2	4.9087	1435	5740	1435
3	7.0686	2070	8280	2070
3 1/2	9.6211	2810	11250	2810
4	12.5660	3675	14700	3675
4 1/2	15.9040	4650	18600	4650

[1] Capacity of safety valve based on 33 1/3 per cent over-pressure, valve set to relieve at 5 lb. per sq. in.

Note: For the purpose of these computations 240 heat units or 0.25 lb. of steam per hour shall be considered as the equivalent of a square foot of steam radiation.

H-107. When a hot-water supply is heated indirectly by steam in a coil or pipe, the pressure of the steam used shall not exceed the safe working pressure of the hot-water tank, and a water-relief

TABLE H-11 MINIMUM ALLOWABLE SIZES OF WATER-RELIEF VALVES FOR WATER-HEATING BOILERS AND FOR WATER-SUPPLY BOILERS

Diameter of Valve, In.	Rated capacity in Sq. ft. Water Radiation	—Rated Capacity in Gallons per Hour— 25° rise	50° rise	100° rise
1/2	750	540	270	135
3/4	2000	1440	720	360
1	3500	2520	1260	630
1 1/4	7500	5400	2700	1350
1 1/2	15000	10800	5400	2700
2	30000	21600	10800	5400

Note: For the purpose of these computations 150 heat units per hour shall be considered as the equivalent of a square foot of water radiation.

valve of at least 1 in. in diameter, set to relieve at or below the maximum allowable working pressure of the tank, shall be used.

H-108. Steam Gages. Each steam boiler shall have a steam gage connected to the steam space or to the water column, or its steam connection, by means of a siphon or equivalent device of sufficient capacity to keep the gage tube filled with water and so arranged that the gage cannot be shut off from the boiler except by a cock placed near the gage and provided with a tee or lever handle arranged to be parallel with the pipe in which it is located when the cock is open. Pipe connections to steam gages smaller than 1 in. pipe size, shall be of brass, copper, or bronze composition when the distance between the gage and point of attachment of pipe is over 5 ft. If less than 5 ft., the connections shall be of brass, copper, or bronze composition if smaller than 1/2 in. pipe size. The dial of a steam gage for a steam-heating boiler shall be graduated to not less than 30 lb. and shall be provided with a stop pin at the zero and maximum points and the graduations shall not occupy more than 325 degrees of the dial circumference.

H-109. Pressure or Altitude Gages. Each hot-water boiler shall have a gage connected in such a manner that it cannot be shut off from the boiler except by a cock with tee or lever handle, placed on the pipe near the gage. The handle of the cock shall be parallel to the pipe in which it is located when the cock is open. Pipe connections to gages smaller than 1 in. pipe size, shall be made of brass, copper, or bronze composition when the distance between the gage and point of attachment of pipe is over 5 ft. If less than 5 ft., the connections shall be of brass, copper, or bronze composition if smaller than 1/2 in. pipe size. The dial of the pressure or altitude gage shall be graduated to not less than 1 1/2 times the maximum allowable working pressure, and shall be provided with a stop pin at the zero and maximum points and the graduations shall not occupy more than 325 degrees of the dial circumference.

H-110. Thermometers. Each hot-water boiler shall have a thermometer so located and connected that it shall be easily readable when observing the water pressure or altitude. The thermometer shall be so located that it shall at all times indicate the temperature in degrees fahrenheit of the water in the boiler, at or near the outlet.

H-111. Temperature Combustion Regulators. A temperature combustion regulator which will control the rate of combustion to prevent the temperature of the water from rising above 250 deg. fahr., at or near the outlet, or an equivalent thermostatic relieving device shall be used on all hot-water boilers.

H-112. Pressure Combustion Regulators. When a pressure combustion regulator is used, it shall operate to prevent the steam pressure from rising above 15 lb.

H-113. Bottom Blow-Off. Each boiler shall have a blow-off pipe connection fitted with a valve or cock not less than 3/4 in. pipe size connected with the lowest water space practicable.

H-114. Water-Gage Glasses. Each steam boiler shall have at least one water-gage glass.

H-115. Gage Cocks. Each steam boiler shall have two or more gage cocks located within the range of the visible length of the water glass.

H-116. Water-Column Pipes. The minimum size pipes connecting the water column of a steam boiler shall be 1 in. Water-glass fittings or gage cocks may be connected direct to the boiler. No connections, except for combustion regulator, drains or steam gages, shall be placed on the pipes connecting a water column to a boiler. If the water column or gage glass is connected to the boiler by pipe and fittings, crosses or tees shall be used on the water connection to facilitate cleaning.

H-117. Fusible Plugs. A fusible plug, if used, shall be placed at an accessible point in the combustion chamber.

Hydrostatic Tests

H-118. All hot-water boilers, the maximum allowable working pressure of which is not in excess of 30 lb. per sq. in., and steam-heating boilers, shall be subjected to a hydrostatic test of 60 lb. per sq. in. both at the shop where made, on each individual section and in the field when erected and ready for service. Hot-water boilers, the maximum allowable working pressure of which exceeds 30 lb. per sq. in., shall be subjected to a hydrostatic test of 2 1/2 times the maximum allowable working pressure both at the shop where made, on each individual section, and in the field when erected and ready for service.

Any hydrostatic pressure test to be made on either a steam-heating boiler or hot-water boiler, after the boiler has been in service, shall be at a pressure of 1 1/2 times the maximum allowable working pressure.

In making hydrostatic pressure tests the pressure shall be under such control that in no case shall the required test pressure be exceeded by more than 6 per cent.

H-119. Individual shop inspection shall not be required for boilers which come under the rules of this section.

H-120. All boilers shall be plainly and permanently marked with the manufacturer's name and the maximum allowable working pressure. All letters and figures shall be at least 5/16 in. high.

The maximum allowable working pressure shall be stamped, cast, or irremovably attached to the front and rear cored sections of vertical sectional cast-iron boilers and on the dome section of horizontal sectional cast-iron boilers. The marking of maximum allowable working pressure on cast-iron boilers suitable for use for steam or water shall be as follows:

MAX. W.P......... LB.
STEAM............ 15
WATER...........

Boilers suitable for use as water boilers only shall be marked as follows:

MAX. W.P........ LB.
WATER...........

All boilers built according to these rules, and no other boilers, shall be marked A.S.M.E. Standard-Heat as follows:

A.S.M.E. STD.-HEAT.

The symbol authorized for use on power boilers shall not be used on heating boilers.

When an insulating or other form of covering is used that portion of the front cored section of vertical sectional cast-iron boilers, and the dome cored section of horizontal sectional cast-iron boilers bearing the foregoing marking, shall either be provided with a removable cover plate or be left uncovered.

APPENDIX

A.S.M.E. Code in Hawaiian Islands

Mr. W. E. Smith, Chief Inspector of the Hawaiian Sugar Planters' Association, reports that the Association controls 42 sugar plantations in the Hawaiian Islands and that a Bureau of Boiler Inspection has been established to control the inspection of new boilers as well as to cover the construction of all new boilers. It was decided when the work of inspection was started in 1919, to adopt the A.S.M.E. Boiler Code which has been followed throughout in the control of the 378 mill and pump boilers of the Association. These comprise 90 per cent of all boilers in the Hawaiian Islands.

The pressure is being reduced on all h.r.t. boilers with double-riveted lap longitudinal seams according to the Code and it is the intention of the Association to eliminate these boilers just as soon as possible.

The Code is being carried out to the letter and they are at the same time obtaining the latest operation data from the states that all of their plants may be brought up to the standard. All steam plows and locomotives are being inspected and all new locomotives furnished the Association are being built according to the A.S.M.E. Code. All rules contain the words, "the latest edition of the A.S.M.E. Boiler Code," thus taking care of the issue of all new editions of the Code.

Test Code for Feedwater Heaters

Preliminary Draft of the Seventh in the Series of Nineteen Test Codes Being Formulated by the A.S.M.E. Committee on Power Test Codes

IN 1918 the Power Test Committee of the A.S.M.E. was reorganized to revise and enlarge the Power Test Codes of the Society, published in 1915. The Committee is a large one, consisting of a Main Committee of 25 members under the chairmanship of Fred R. Low, and 19 Individual Committees of specialists who are drafting codes for the different classes of apparatus comprised in power-plant equipment. Below is reproduced the seventh of these codes to be completed, namely, the Test Code for Feedwater Heaters.

The Individual Committee which developed this Code is headed by Mr. George A. Orrok as Chairman, and consists of Philip E. Reynolds, Secretary, Charles H. Baker, Jr., Raymond N. Ehrhart, George J. Foran, J. J. Mullan and Milton C. Stuart. Mr. Foran was chairman of the Committee from the time of its organization in December, 1918 until his death in May, 1921.

The Committee and the Society will welcome suggestions for corrections or additions to this draft of its Code from those who are specially interested in the manufacture and use of Feedwater Heaters. These comments should be addressed to the Secretary of the Committee in care of The American Society of Mechanical Engineers.

Introduction

1 This code applies to open and closed boiler feedwater heaters, and with slight modifications to suit special conditions, it may apply to heaters for heating water for any purpose when the heating element is either live or exhaust steam. In the open-type heater the heating steam mixes directly with the water to be heated. In the usual arrangement of closed-type heater the water passes through tubes surrounded by the heating system, though this arrangement may be reversed.

A feedwater heater is designed to heat a certain quantity of water through a given temperature range with a certain steam temperature or pressure available, with a limited loss of friction head in water flowing through the heater, and with a limited loss of steam through vents or stack.

Object

2 There may be several objects of the tests, as pointed out in the "General Instructions," but usually they are conducted:

(*a*) To determine whether the heater meets the designed conditions

(*b*) To determine the variation of temperature rise of water and friction drop in water with capacity. (Closed heaters.)

(*c*) To determine the closeness with which the outlet-water temperature approaches the steam temperature corresponding to the pressure in the heater (open heater).

The heat-transfer coefficient proves to be a useful and interesting item in connection with the analysis of a test of a closed feed-water heater. The heat-transfer coefficient is not, however, the sole measure of the merit of a heater.

Instruments and Apparatus

3 The instruments and apparatus required for a heater test consist of the following:

(*a*) Barometer, preferably of the mercurial type

(*b*) Mercury columns for measuring vacuums and low pressures having scale graduations of not greater than 0.1 inch with vernier attachment

(*c*) Bourdon gages for measuring pressures when too high for mercury columns

(*d*) Thermometers:

(1) For determining temperatures of feed water, condensate and vapors—graduated by half degrees and with scale readings from 32 to 300 or 350 deg. fahr.

(2) For determining steam temperature—graduated by degrees with scale readings from 32 to 300 or 350 deg. fahr.

(*e*) Tanks and platform scales for measuring water (or water meters calibrated in place under conditions of use)

(*f*) Steam calorimeter, throttling or separating, depending upon amount of moisture present and pressure. (See Code on Instruments and Apparatus, Par.—

(*g*) Apparatus for testing oxygen content of water.

It is desirable that wherever possible observation of rate of water flow, pressures and temperatures be obtained by continuous recording instruments, in addition to the observations made by the more precise instruments for instantaneous measurements.

General directions for the application, use and calibration of these instruments and apparatus, and information regarding their range and accuracy are given in the section of the code dealing with "Instruments and Apparatus."

Identically the same testing apparatus for measuring the quantity of steam condensed in the case of closed heaters may be employed as that used for testing the engine, turbine or other steam machinery supplying the feedwater heater. (See Codes for Steam Engines, Steam Turbines, etc.). For measuring feedwater the same kind of apparatus may be employed as that used in pumping-engine or water-wheel tests, such as weirs, nozzles, orifices, pitot tubes. (See Code on Instruments and Apparatus, Pars.——).

4 In preparing for the heater test, the "General Instructions" should be first carefully studied. The dimensions and physical conditions should then be ascertained. The starting, stopping and duration of the test should follow the same rules as those governing a steam engine test, and reference may be made to the Test Code on Reciprocating Steam Engines for the general directions to be followed.

Open Heaters—Installation, Test and Calculation of Results

5 In the open heater, which is also sometimes referred to as the "direct-contact" heater, in which the steam mixes directly with the water, it is possible to so design the water-distributing system that, over a wide range of capacity, the water will be heated to within a few degrees of the steam temperature corresponding to the pressure in the heater. In most open feedwater heaters, the purpose is not only to heat the water, but to filter or treat the water as well, and in these cases arrangements must be made to obtain analyses of the water entering and leaving the heater. Open feedwater heaters are also frequently used for partial deaeration of the water, and in such cases means should be provided for sampling the water and determining its oxygen content.

6 Inasmuch as the open feedwater heater serves as a storage tank supplying the boiler-feed pumps, the time required to empty the heater during normal operating conditions in case of failure of the supply of water to the heater is very important in establishing the rated capacity and size of heater. Of equal importance in establishing heater capacity is the time lag between the occurrence of an insufficiency of steam for a desired outlet temperature and the appearance of this improper temperature at the water outlet. These times will depend upon heater arrangement as well as volume of storage, and the test should if possible determine these items in terms of definite rates and temperatures.

Closed Heater—Installation, Test and Calculation of Results

7 In a closed feedwater heater there is a definite relation between the capacity and outlet-water temperature which is determined by the ability of the surface to transfer heat. This ability of the surface to transfer heat under any given set of conditions is measured by the Heat-Transfer Coefficient. The principal items affecting the value of the heat-transfer coefficient are, (*a*) tube type, length and

arrangement, (b) water velocity, (c) condition of tubes as regards the presence of a film of scale, oil or dirt, and (d) the presence of accumulated air in the steam space of the heater.

8 During the test of the closed heater, as well as during operation, provision should be made to keep the shell thoroughly drained of condensate and vented of air. Accessories necessary for good operation are pressure gage, thermometers, safety valve, vacuum breaker, water-gage glass and trap.

9 The location of thermometer in the steam space is of considerable importance. It must not be installed where there is liable to be an air pocket nor must it be near a cold water manifold. If near cold tubes it must be shielded for radiation.

Calculation of Results

10 The logarithmic heat transfer coefficient expressed in British Thermal Units per hour per sq. ft. of surface per degree of logarithmic mean temperature difference is computed from the following formula

$$K = \frac{W}{S} \log_e \frac{T_s - T_i}{T_s - T_0}$$

in which

K = heat transfer coefficient
W = pounds of water per hour
S = heating surface, measured on the outside of the tubes in sq. ft.
T_s = steam temperature in heater (if superheated steam is supplied, use temperature of saturated steam at the pressure in heater)
T_i = inlet water temperature
T_0 = outlet water temperature

11 After working up the items tabulated, it is desirable to plot the results on logarithmic paper. The heat-transfer coefficient when plotted against the velocity of water in tube, almost invariably gives a straight line on logarithmic paper. This curve then gives the data for determining constants in the equation

$$K = aV^n$$

in which

K = heat-transfer coefficient
V = velocity of water, ft. per sec.

12 Friction drop when plotted against velocity usually gives a straight line on log paper which serves to determine constants in friction drop formula,

$$H = bLV^m$$

in which

H = total friction drop, lb. per sq. in.
L = length of tube, ft. (if multipass, length of total path of travel of water in heater)
V = velocity of water, ft. per sec.

The constants obtained in these formulas may be used to compare the performance of the heater under test with the performance of other heaters.

Records

13 The directions given in the Code on General Instructions under this heading should be followed in taking and recording the readings of instruments and other data.

TABLE 1 DATA AND RESULTS OF TEST CODE FOR OPEN FEEDWATER HEATERS

General Information

(1) Date of test. . . . .
(2) Location of plant. . . . .
(3) Owner. . . . .
(4) Builder. . . . .
(5) Test conducted by. . . . .
(6) Object of test. . . . .

Descriptions and Dimensions, Etc.

(7) Type of heater. . . . .
(8) External dimensions of heater. . . . .
(9) Gross volume of heater. . . . . cu. ft.
(10) Weight of heater, empty. . . . . lb.
(11) Weight of heater when operating (including water). . . . . lb.
(12) Volume of steam space. . . . . cu. ft.
(13) Shape and dimensions of steam inlet opening into heater. . . . . . in.
(14) Size of water inlet. . . . . in.
(15) Size of water outlet. . . . . in.
(16) Material of shell. . . . .
(17) Volume of water in heater at operating water level. . . . . cu. ft.
(18) Volume of water between overflow level and level at which make-up valve will open. . . . .
(19) Rated capacity of heater, water per hour. . . . . lb.
(20) Location of thermometers. . . . .
(21) Number and arrangements of baffles or trays. . . . .
(22) Description of filtering or purifying arrangement. . . . .
(23) Size and arrangement of venting connections. . . . .
(24) Description of metering apparatus installed in heater. . . . .
(25) Description of automatic steam and water control. . . . .
(26) Description of water distributing boxes. . . . .
(27) Nature and amount of insulation on heater. . . . .

Observed Data

(28) Duration of test. . . . .
(29) Barometer. . . . . in. hg.
(30) Room temperature. . . . . deg. fahr.
(31) Quantity of water admitted to heater. . . . . lb. per Hr.
(32) Inlet-water temperature. . . . . deg. fahr.
(33) Outlet-water temperature. . . . . deg. fahr.
(34) Steam pressure in heater, gage. . lb. per sq. in. or in. of mercury
(35) Steam temperature in heater, by thermometer. . . . . deg. fahr.
(36) Steam temperature at inlet by thermometer. . . . .
(37) Steam used per hour. . . . . lb.
(38) Total water discharged from heater. . . . . lb. per hr.
(39) Volume of water in mixing compartment of heater. . . . .
(40) Volume of water in storage compartment of heater. . . . .
(41) Pressure drop from steam end of heater to vent end. . . . .
(42) Time lag between occurrence of steam deficiency and change of outlet temperature. . . . .
(43) Analysis of water entering heater. . . . .
Analysis of water leaving heater. . . . .
(44) Oxygen content of water entering heater. . . . .
(45) Oxygen content of water leaving heater. . . . .

Computed and Deduced Results

(46) Steam temperature corresponding to absolute pressure. . deg. fahr.
(47) Quality of steam supplied to heater, per cent moisture or degree superheat. . . . .
(48) Temperature difference between steam temperature corresponding to heater pressure and outlet water temperature. . . . . deg. fahr.
(49) Lb. steam theoretically required per lb. water. . . . .
(50) Lb. steam used per lb. water, actual. . . . .
(51) Time required to empty heater when operating at rated capacity.
(52) Steam lost up stack. . . . . lb. per hr

TABLE 2 DATA AND RESULTS OF TEST CODE FOR CLOSED FEED WATER HEATERS

General Information

(1) Date of test. . . . .
(2) Location of plant. . . . .
(3) Owner. . . . .
(4) Builder. . . . .
(5) Test conducted by. . . . .
(6) Object of test. . . . .

Descriptions, Dimensions, Etc.

(7) Type of heater. . . . .
(8) Position of heater, horizontal or vertical. . . . .
(9) Condition of heating surface. . . . .
(10) Number of tubes. . . . .
(11) Number of passes. . . . .
(12) Length of single tube. . . . . ft., in.
(13) Distance of travel of water through heater. . . . . ft., in.
(14) Special type of tube, description. . . . .
(15) Outside diameter of tube. . . . . in.
(16) Thickness of tube. . . . . in.
(17) Heating surface, of tubes, outside of tube. . . . . sq. ft.
(18) Diameter of heater over shell. . . . . ft., in.
(19) Length of heater over shell. . . . . ft., in.
(20) Thickness of shell. . . . . in.
(21) Material of tubes. . . . .
(22) Material of shell. . . . .
(23) Weight of heater, empty. . . . . lbs.
(24) Weight of water in heater. . . . . lbs.
(25) Gross volume of heater. . . . . cu. ft.
(26) Shape and dimensions of steam inlet opening into heater. . . . . in.
(27) Arrangement of steam supply pipes into heater. . . . .
(28) Size of water inlet and outlet. . . . . in.
(29) Size of drain. . . . . in.
(30) Type and size of drain trap. . . . .
(31) Location and type of air vents. . . . .
(32) Arrangement of baffles. . . . .
(33) Nature and amount of insulation on heater. . . . .
(34) Location of thermometers. . . . .

Observed Data

(35) Duration of test. . . . .

(Continued on page 765)

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Helium

THE story of helium is one of the romances of science. Probably nothing, except perhaps radium, compares with it in human interest. Helium is one of the best examples of a discovery in pure science that has wide commercial application. In 1868 an eclipse of the sun was visible in India, and several scientific men who were in India making observations of the eclipse turned a spectroscope for the first time on the solar chromosphere—that part of the atmosphere of the sun, about 10,000 miles deeps, which merges into the corona. A bright yellow line was observed and was thought at first to be due to sodium. Janssen showed, however, that this line was not just the same as either the D_1 or D_2 line of sodium, although it was extremely close to these lines, hence he suggested that the new line have the designation D_3. Frankland and Lockyer decided that D_3 was due to an element in the sun not previously discovered on the earth, and suggested for it the name "helium" from the Greek word "helios," the sun.

Helium is found in the atmosphere, in the proportion of one part by volume in 185,000. From samples of air taken at an altitude of several miles and analyzed, the proportion of helium has proved to be about the same as at lower levels; at extremely high altitudes, such as 100 miles or more, the proportion may, however, be much increased. Helium is also found in very minute quantities in sea and river water; undoubtedly it exists in some of the fixed stars as well as in the sun, and its presence has been spectroscopically determined in many nevulae. Helium is found in the gases evolved from many mineral springs; some contain a high percentage of helium, notably the gas from mineral springs at Mazières, France, which has over 5 per cent of helium, and two springs at Santenay, France, with more than 8 per cent. But the total amount of these gases is relatively too small for the extraction of helium from them to be feasible for practical uses.

In 1907 Cady and McFarland of the University of Kansas published a report on the presence of helium in several natural gases, mainly Kansas gases. Some of the samples tested ran as high as 1½ per cent of helium by volume. This work of Cady and McFarland disclosed the information necessary for the inauguration for the helium "project" during the war.

To date no one has succeeded in combining helium with any other element, or in inducing the gas to take part in any chemical reaction under any conditions. In this respect, it is similar to the other rare gases o 'he atmosphere—neon, argon, krypton, and xenon. Helium is only slightly soluble in water. Its thermal conductivity is fairly high, but it is less than that of hydrogen. A volume of helium weighs about twice as much as an equal volume of hydrogen under identical conditions of temperature and pressure. It is a good conductor of electricity, being next to neon in this respect. Under similar conditions it conducts a current 25 times as readily as air. After overcoming immense difficulties, Professor Kammerlingh Onnes, of the University of Leyden, in 1908, succeeded in liquefying helium. The liquid boils at −268.75 deg. cent. or 4.25 deg. absolute. Solid helium has not yet been obtained.

As a gas to replace the inflammable hydrogen used in dirigibles, helium has many advantages. Besides being non-inflammable it is the only gas known to be light enough to replace hydrogen as a lifting force. The use of helium has still other advantages: It diffuses through a fabric at about three-quarters the rate of hydrogen; and its non-inflammability makes it possible to place the engines in the framework of the dirigible, thus getting a direct drive, giving greater control of the craft and much increased speed for any given horsepower.

Early in 1915 word came to an official of the Bureau of Mines that the British were interested in sources of helium for use in dirigibles. When the United States entered the war in 1917, helium for use in dirigibles was discussed among Bureau of Mines officials, and in June the matter was presented to the Army and Navy Air Services as a war project. These services enthusiastically approved the proposition, and allotments of money were made from the Army and Navy appropriations to carry it forward.

Three experimental plants were constructed in Texas under the direction of the Bureau of Mines, two at Fort Worth for economic reasons; one plant used the Linde system of liquefaction, the other the Claude system, and the supply of gas was piped to the plants from Petrolia, Texas. Analysis has shown that this gas contained 0.95 per cent helium. Another plant was later constructed at Petrolia, near the gas wells, and use was made of a new method of liquefaction called the Jefferies-Norton process.

All three plants produced helium, but the Linde plant proved the most efficient, and it was decided to construct, under the cognizance of the Navy, a much enlarged plant for obtaining helium in greater quantities. The construction of this plant was started in October, 1918; it was completed in December, 1920, and was operated during part of 1921. It produced altogether about 2,000,000 cu. ft. of helium, which, with the helium obtained at the smaller plants during the experimental period, makes available at the present time a total of about 2,400,000 cu. ft. of helium over 90 per cent in purity. Most of the gas is around the 95 per cent grade.

The method of operation in all of these plants is, in general, the same, although there is considerable difference in detail. The object is to liquefy all of the elements making up the natural gas except the helium, which does not liquefy at the temperature used. After liquefaction of all other constituents in the gas—such a nitrogen, methane, ethane, propane, and butane—the helium can be pumped off. Thus far helium has been obtained in two stages. One stage in operation gives about 70 per cent purity; this has been refined up to 95 per cent. In the second operation the nitrogen, representing practically all the impurity, is liquefied and the helium is once more pumped off.

Complete equipment for conducting research at low temperatures, the Cryogenic Laboratory of the Bureau of Mines, is located at Washington in the Interior Department building, representing the research department of the whole helium project, and employing a force of 12 men. Fundamental information is being obtained that is essential for the construction of any new plant designed to have greater efficiency than the large plant at Fort Worth. Helium can probably be produced in this plant for 10 cents a cubic foot, but it is believed that the cost can, ultimately, be reduced to 3 cents and perhaps to 2 cents. Necessary information is being gradually accumulated to this end.

R. B. Moore,
Chief Chemist, Bureau of Mines.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Aeronautics A2-22. Radiators for Aircraft Engines. The purpose of this report is to show the relations between the conditions under which the radiator operates, its characteristics of form and construction, and the properties that describe its performance, together with a detailed description of the experimental work on which the conclusions are based. The limitations of such a treatise in its immediate application, without any intervening step, to certain problems of design is the obvious one imposed by the impossibility of predicting for each possible case in actual practice the conditions which will determine the air flow. All of the work discussed in this paper and the results of the measurements recorded can be applied, provided only that the air flow through the core be known.

The material compiled in this treatise is based upon the war work and postwar work of the Bureau of Standards on the subject of aircraft

radiators. Individual reports covering many phases of the subject have been published previously in the technical series of the National Advisory Committee for Aeronautics and in scientific and engineering journals. These reports, however, lack the systematic coördination, uniform terminology, and unified mathematical treatment which should characterize a handbook on the subject.

This report is known as Bureau of Standards Technologic Paper No. 211, by Messrs. S. R. Parsons and D. R. Harper, 3d. It may be obtained by addressing the Superintendent of Documents, Government Printing Office, Washington, D. C. Price per copy, 50 cents.

Air A2-22. The Reheating of Compressed Air. University of Illinois Bulletin No. 130, by C. R. Richards and J. N. Vedder. This investigation of the reheating of compresssed air was undertaken to determine the ideal thermodynamic efficiencies resulting from the heat expended in the reheating process, the efficiency of external- and internal-combustion reheaters, the performance of an engine using air expansively under a wide variety of operating conditions, and the performance of the same engine operating with steam alone, and with mixtures of air and steam when steam is injected into the air pipe as a means of reheating the air.

The results of the investigation of reheaters show that in small external combustion reheaters maximum efficiencies of from 16.7 to 61.5 per cent may be secured, depending upon the type of reheater employed; and that in the internal-combustion reheater of the type tested the efficiency varied from 69.4 per cent when 326 lb. of air per hour was heated, to 83.0 per cent when 1240 lb. of air per hour was heated.

In the tests of the engine using a mixture of air and steam it was found that the work done per pound of mixture was considerably in excess of that attainable by the separate use of the same weight of each ingredient in the mixture. The interest in air-steam mixtures developed during this investigation has led to further studies of the subject, the results of which will be presented in a later bulletin.

This bulletin may be obtained by addressing the University of Illinois, Engineering Experiment Station, Urbana, Illinois. Price per copy, 50 cents.

Automotive Vehicles and Equipment A2-22. Sixth Semi-Annual Motor Gasoline Survey. See *Fuels, Gas, Tar and Coke A12-22.*

Cement and Other Building Materials A5-22. Action of Alkali on Concrete. This paper reports the results of inspection in 1919 and 1920 of experimental drain-tile and concrete-block installations at eight alkali-bearing projects in the West. The investigation has been carried on since 1913, and the conclusions to date are that the best quality of concrete will disintegrate when exposed to severe alkali attack, and that installations of concrete in soils containing more than 0.1 per cent of salts of the sulphate type should be preceded by an examination of surrounding conditions.

Mr. G. M. Williams, associate engineer of the Bureau of Standards, in coöperation with seven others prepared this report which is designated as Technologic Paper No. 214. Address Superintendent of Documents, Government Printing Office, Washington, D. C. Price per copy, 10 cents.

Cement and Other Building Materials A5-22. Flexural Strength of Plain Concrete. For many years little attention has been given to the flexural strength of concrete, due to the practice of disregarding the tensile stresses in the concrete in the design of reinforced-concrete members and structures. With the advent of concrete roads and pavements, the flexural strength of concrete again became important; it may in fact prove the determining factor in working out a rational and economical design of slabs for this purpose. Concrete roads have presented many new engineering problems, one of which is the design of a comparatively thin slab to carry heavy rolling loads. Critical tensile stresses may occur in any direction, in either the top or bottom surface; the span length is uncertain on account of the indeterminate nature of the support. To provide adequate steel reinforcement would involve a prohibitive expense, consequently engineers have come to realize that primary dependence must be placed on the ability of the plain concrete to develop the flexural strength necessary for a proper distribution of the load over the subgrade. The exact thickness of slab necessary for this purpose cannot now be fixed by mathematical analysis, but must be determined as a result of experience. Considerable advance toward a rational design of road slabs may be expected to result from the studies of subgrade soils, the effect of moisture and temperature on the slab, and the effect of impact that are now being carried out by the U. S. Bureau of Public Roads and a number of the state highway departments.

The tests covered by this report were made as a part of a general investigation of concrete and concrete materials being carried out through the coöperation of Lewis Institute and the Portland Cement Association, at the Structural Materials Research Laboratory, Chicago. Address the author, Prof. Duff A. Abrams, Professor in Charge of Laboratory.

Corrosion A2-22. Corrosion under Oil Films. With Special Reference to the Cause and Prevention of the After-Corrosion of Firearms. This report, known as Technical Paper 188, was prepared by Wilbert J. Huff and was recently published by the Bureau of Mines.

Toward the end of the world war the Bureau of Mines was requested to investigate the causes of after-corrosion upon the bore surfaces of the infantry service rifle, with the ultimate purpose of developing some simple procedure for eliminating this serious menace. The Ordnance Department of the Army says that probably more rifles are ruined by improper preparation for storage than by any other cause; and the problem, though primarily military, touches the interest of every owner of a firearm.

The importance of this study is not, however, limited to the users of firearms. The fundamental problem proved to be corrosion under oil films; this differentiates after-corrosion sharply from the ordinary corrosion of clean iron and steel surfaces. It will be shown that this after-corrosion is closely allied to a number of other general problems, such as the corrosion under oil of bright steel parts after handling in manufacturing operations, and to the corrosion under oil experienced near the ocean.

This paper first reviews the numerous theories that have been advanced to account for this after-corrosion. It then describes certain experiments which were conducted and concludes with a number of practical suggestions. Address Superintendent of Documents, Government Printing Office, Washington, D. C. Price per copy, 5 cents.

Corrosion A3-22. Action of Alkali on Concrete. See *Cement and Other Building Materials A-522.*

Ferrous Alloys A2-22. Experimental Production of Certain Alloy Steels. In 1917 the Bureau of Mines received information from a creditable source that Germany was using uranium steel in the liners of some high-power naval guns. It was stated that uranium stiffens steel at high temperatures, and raises the softening point some 200 deg. cent., so that gun erosion is reduced. The fact that the German guns retained accuracy of fire at the end of the Jutland naval engagement was ascribed to the uranium-steel gun liners. The report agreed with previous less circumstantial reports. Somewhat similar reports had been received as to the use of molybdenum steel.

About four years ago, therefore, the Bureau began a series of experiments with small heats of uranium steels produced with the electric-furnace equipment of Cornell University. The Michigan Steel Castings Company and the Halcomb Steel Company coöperated in the earlier experiments, and later the Vanadium Corporation of America and the Welsbach Company took a part. Before the work had progressed very far the need for an electric furnace adapted to this purpose was realized. Such a furnace was developed and then the experiments progressed more rapidly and were extended to many other alloy steels.

This Bulletin 199, written by Messrs. H. W. Gillett and E. L. Mack, records valuable data connected with the preparation and study of uranium, manganese, molybdenum, chromium, vanadium, nickel, aluminum, zirconium, cerium and boron steels. It closes with a summary of results, conclusions and a list of publications on ferrous metallurgy.

Address Superintendent of Documents, Government Printing Office, Washington, D. C. Price per copy, 15 cents.

Foundry Equipment, Materials and Methods A3-22. Inclusions in Aluminum-Alloy Sand Castings. See *Non-Ferrous Metals A1-22.*

Fuels, Gas, Tar and Coke A12-22. Sixth Semi-Annual Motor Gasoline Survey. For several years the Bureau of Mines has conducted surveys to determine the changes in motor gasoline being sold throughout the United States. The present survey shows that for the districts in which samples were collected, the average gasoline is becoming more volatile instead of less so, as is sometimes supposed. This year's gasoline is much more volatile than that sold two years ago, and it has a somewhat better distillation range than last summer's samples. A comparison of the average figures for several years, shows that motor gasoline is also becoming more uniform in character. The large seasonal change is disappearing, but "winter gasoline" still has a lower initial boiling point than "summer gasoline." This difference in volatility is made intentionally to facilitate starting the motor in cold weather. The end point shown in the present survey is slightly lower either than that of last winter or of the summer of 1921.

The report on this survey, known as Serial No. 2388, was written by Messrs. A. D. Bauer and N. F. LeJeune, both assistant chemists of the Bureau of Mines.

Instruments and Apparatus A3-22. The Redwood Viscometer. It is generally believed necessary to standardize viscosimeters or viscometers at more than one temperature. If this is correct, all instruments of a given type must be made of materials of approximately the same thermal coefficients of expansion, and the use of only one calibrating liquid at two different temperatures would be inadequate, even if the experimental error were assumed negligible.

The Redwood viscometer was selected for calibration because there appeared to be some doubt whether or not the instrumental constants varied with the temperature. By the use of oils whose viscosity had been determined in a capillary-tube instrument the following equation was obtained:

$$\text{Kinematic viscosity} = 0.00260t - \frac{1.88}{t}$$

where t is the time of flow in seconds.

Two common errors in viscosimetry were investigated, with the following conclusions:

1 That the error due to inaccuracy in the Meissner formula for average head is negligible in ordinary work.

2 That the error due to cooling of the oil after leaving the outlet tube may be neglected at low temperatures, but should be corrected

at temperatures near the boiling point of water. Thus, any observed variation in instrumental constants at different temperatures is probably due to the last-mentioned error, so that viscosimeters may be calibrated at any convenient temperature, and outlet tubes may be made of any suitably durable and non-corrosive material without regard to its coefficient of expansion.

Mr. W. H. Herschel, associate physicist of the Bureau of Standards, prepared this report, a copy of which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. by asking for Technologic Paper No. 210. Price per copy, 10 cents.

Iron and Steel A5-22. EXPERIMENTAL PRODUCTION OF CERTAIN ALLOY STEELS. See *Ferrous Alloys A2-22.*

Lubricants A1-22. THE REDWOOD VISCOMETER. See *Instruments and Apparatus A3-22.*

Non-Ferrous Metals A1-22. INCLUSIONS IN ALUMINUM-ALLOY SAND CASTINGS. Although many representative aluminum-alloy founders by care in practice have been able practically to eliminate hard spots and resulting trouble when aluminum-alloy castings are machined, others still have periodic difficulties because of this defect. A number of foundrymen have suggested at various times that the Bureau of Mines investigate hard spots, put the available information on record, and suggest preventive methods. Such an investigation was undertaken and carried out in connection with the Bureau's work on casting losses in aluminum-alloy foundry practice. The present paper is published as a contribution to the literature of aluminum-foundry practice and as a guide to founders in preventing scrap losses from hard spots in castings.

In conducting the present investigation a number of aluminum-alloy founders were requested to outline their experience with hard spots and to submit typical samples of castings containing this defect. The information thus gathered was analyzed, and the samples submitted were examined microscopically. In this way the experience of representative foundrymen has been made available, and practically all possible kinds of hard spots have been examined. Furthermore, an investigation was made of the actual conditions in a foundry which was in the throes of an epidemic of hard spots for six or eight weeks. In addition, hard spots were produced purposely in sand castings.

Mr. R. J. Anderson is the author of this Technical Paper 290 and concludes the report of his investigation with a number of helpful suggestions. Address the Superintendent of Documents, Government Printing Office, Washington, D. C. Price per copy, 10 cents.

Steam Power A4-22. THE REHEATING OF COMPRESSED AIR. See *Air A2-22.*

Ventilation A1-22. EFFECTS OF BREATHING CARBON DIOXIDE. Experiments on the effects of breathing carbon dioxide have been conducted at the Pittsburgh, Pa., station of the U. S. Bureau of Mines under the direction of Dr. R. R. Sayers, chief surgeon of the Bureau, and A. C. Fieldner, supervising chemist. About 2 per cent of carbon dioxide in oxygen produced a slight increase in lung ventilation but no subjective symptoms; 5 per cent in oxygen caused an increase in lung ventilation of about 100 per cent, but no other signs or symptoms; 7.2 per cent produced about 200 per cent increase in lung ventilation and moderate perspiration and a slight fullness in the head were experienced after breathing the mixture for 10 minutes; 9 to 10 per cent produced about 300 per cent increase in lung ventilation, and the subject complained of frontal headache and was dizzy and perspiring at the end of 10 minutes. About 9 per cent of carbon dioxide in oxygen was breathed by some of the subjects for as long as 45 minutes, but the breathing was very laborious, and dizziness, headache, and perspiration were marked. In fact, to have done any work while breathing this mixture would have been extremely difficult.

Wood Products A4-22. WOOD-PRESERVING TERMS. Predominantly wood preservation is an engineering subject. Messrs. E. F. Hartman and E. F. Paddock have therefore rendered a great service in the preparation of this complete and full glossary of the terms employed in this industry. This pamphlet comprises 85 pages and was published by the Protexol Corporation, 34 Barclay Street, New York.

In their introduction the authors state that they have endeavored specially to help those unfamiliar with the language of the wood preserver. In many cases, what were originally simple definitions have been expanded and amplified until in its present form, what was intended merely as a glossary of terms has assumed proportions more nearly approaching those of a textbook. Terms of a technical nature have been included, as well as the strictly industrial terms.

F—BIBLIOGRAPHIES

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Vapor Engines and Turbines F1-22. MERCURY-VAPOR BOILER AND TURBINE. A bibliography has just been completed on this subject and may be obtained by referring to Search No. S 3618, which consists of one page. Address the A.S.M.E. Research Department.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING are solicited. Contributions particularly welcomed are discussions of papers published in this journal, brief articles of current interest to mechanical engineers, or comments from members of The American Society of Mechanical Engineers on activities and policies of the Society in Research and Standardization.

German Standards

TO THE EDITOR:

In the September issue of MECHANICAL ENGINEERING, Mr. Wikander says on page 615, apropos of German industrial standards:

> To give a concrete illustration of this point, I may mention that at the time of my visit, a syndicate of nineteen German and one Swedish manufacturer was executing an order for seven hundred locomotives for Russia, all of the same design, and every part in every one of them was being made interchangeable with the corresponding part in all the others, all parts having been manufactured to the same fits and tolerances. This feature will have the great advantage of permitting the Russian railroads to use any disabled locomotive as a store of spare parts for all the others. In case of future orders, the Russians will no doubt specify that all new locomotives of this class be built not only of the same design as above, but so that every part is interchangeable with the above.

Mr. Wikander refers evidently to the order of the Russian Soviet Government for 700 locomotives to be made in Germany. The contract of the purchaser with the manufacturers *does* specify in Par. 5 that the parts are to be interchangeable, no matter at which of the works they are made, but the same contract also has a clause in the same paragraph stating that it is permissible to make these interchangeable parts fit one another by applying hand operations (filing, scraping, etc.). It can be readily seen that this latter clause kills entirely the preceding one and the whole idea of interchangeability.

This letter is, of course, in no way a criticism of the interchange ability idea in itself.

R. POLIAKOFF.

New York, N. Y.

[A copy of Mr. Poliakoff's letter was submitted to Mr. Wikander whose comment thereon is printed below.—EDITOR.]

TO THE EDITOR:

I beg to acknowledge receipt of a copy of a letter from Mr. R. Poliakoff referring to the order of 700 locomotives for the Russian Soviet Government placed with a syndicate of German manufacturers and which was mentioned in my article on German standards in the September issue of MECHANICAL ENGINEERING.

The article in question was based on verbal information from the leading manufacturer of the locomotives, but the writer did not read the contract, a copy of which seems to be in the hands of Mr. Poliakoff.

It is to be seen from Mr. Poliakoff's letter that, in addition to the paragraph which *does* specify that all parts of the above locomotives are to be interchangeable, there is also a clause stating that it is permissible to make these interchangeable parts fit one another by applying hand operations (filing, scraping, etc.). The writer was not aware of this latter clause and in his opinion it is a kind of a joker which the Germans have placed in the contract so as to defend themselves in case it should not be found possible for them to fulfil the requirement of interchangeability beyond any

question. As a matter of fact, however, the syndicate was able to meet the said requirements to an extent exceeding their own expectations.

New York, N. Y. Oscar R. Wikander.

The Surge Tank Problem

To the Editor:

I have read Mr. R. D. Johnson's letter in Mechanical Engineering for August, 1922, page 541, in which he discusses an article on surge tanks by Professor Durand. He says, on page 542:

> Furthermore, it is difficult for the writer to find any excuse for omitting the differential principle when its use, without exception, produces a cheaper surge tank which will fulfill the same conditions.

In this connection I wish to call attention to the closing discussion of my article on surge tanks, which discussion will be printed in Vol. 85 of the Transactions of the American Society of Civil Engineers. Due to the fact that assertions similar to those made by Mr. Johnson and quoted above were made in discussing my paper, it became necessary to discuss the differential surge tank, and I have shown in this discussion that in case of sudden load demand the differential surge tank is at a distinct disadvantage. It produces faster acceleration by decreasing the head on the plant, which is very undesirable for low- or medium-high-head plants because it lowers the output of the plant at the critical moment when the greatest possible output is desired. The differential surge tank is therefore not generally the best solution of the surge-tank problem. The discussion referred to gives detailed information and curves.

Professor Durand has applied a valuable method of investigating surge-tank problems experimentally and at a nominal cost. This enables the designer to obtain a much better understanding, not alone of the best surge tank for any given condition, but of the action of the surge tank for various load changes, and this should assist materially in deciding the conditions for which the surge tank should be designed. This is perhaps the most difficult part of the whole design.

The article on surge tanks which appears in the April, 1922, Proceedings of the A.S.C.E., pp. 853–69, gives particular regarding tests on a surge tank for a 50,000-hp. plant, and shows the very rapid damping of the oscillations in the cone-shaped surge tank, in spite of the fact that no provisions whatever were made to damp the surges.

Fresno, Cal. B. F. Jakobsen.

Discharge through Orifices in Series

To the Editor:

An investigation was recently made at the Mechanical Engineering Laboratory of The Rice Institute, Houston, Tex., to determine the rate of flow of fluids through sets of orifices in series, so placed that the fluid must pass through each of the orifices in succession.

Various sizes and combinations of sizes of small orifices were tested under different pressure heads in order that a formula for the discharge through orifices in series could be derived, and also to find the effect of the distance between the orifices on the discharge. In order to carry out this test a search tube (Fig. 1) was constructed consisting of two tubes, A and B, the smaller one fitting in the larger, places for inserting orifices for testing being provided at C and D. Small glass tubes inserted in the search tube made it possible to read the pressures on orifices by the height of the water column in the glass tubes. The distance between the orifices was varied by moving the small tube B in or out, while the pressure head thereon was varied by varying the height of a supply tank containing three openings: one for the supply line to the search tube, another for the water inlet, and a third to take care of the surplus water whereby the water level was kept at a constant level. The orifices used were made of copper and were 0.037 in. thick, with the inner edge of the hole square and sharp.

The discharge was determined by weighing the water flow from The orifices on a balance weighing to one-thousandth of a pound and timed by means of a stop watch; also, all readings were checked after an interval of several days.

Fig. 2 shows the weight of water discharged in five minutes for two different sizes of orifices placed in series and discharging under a constant pressure head as the distance between them is varied. The maximum discharge was obtained when the two orifices were separated by a distance of approximately 70 per cent of their diameters; the pressure head on the orifice also changed this value to a certain extent.

Referring to curve No. 1 of Fig. 2, it is seen that the highest value for the discharge of two orifices in series is at the point E. When the two orifices are in contact and form one orifice (distance apart = 0), it will be observed that the discharge is less than when the distance between them is 0.063 in., which separation gives the maximum discharge. Under certain conditions this maximum discharge through two orifices was found to be greater than the discharge through a single orifice under the same conditions. These conditions were found to be: a correct alignment of the two orifices; a pressure head sufficient to give a good contracted jet through the first orifice; and the location of the opening of the second orifice at the point where the cross-sectional area of the jet from the first orifice is a minimum. For two orifices each 0.088 in. in diameter under a pressure head of 12 in. this maximum discharge was found when the orifices were separated a distance of 0.063 in.; when the pressure head was lowered to 3.9 in., however, the maximum discharge was less than that from one orifice of the same diameter (see Fig. 4).

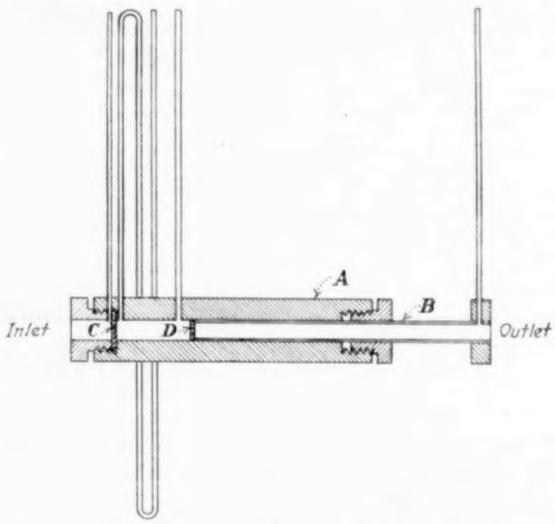


Fig. 1 Cross-Section of Search Tube Used in Testing Orifices in Series

The reason why two orifices will discharge more than one under the conditions named, may be determined by reference to the curves of Fig. 3. These curves show the pressure between the orifices of different sizes with varying distances between the orifices and with the first orifice a constant pressure head. Consider curve No. 4 for two orifices each 0.088 in. in diameter under a head of 12 in. When these orifices are 0.063 in. apart the pressure drops far below atmospheric, causing a pressure drop of 17.5 in. through the first orifice under an external head of 12 in.; while under similar conditions the reading of this pressure drop for a single orifice of the same size was only 14.93 in. of water. This may be explained by the fact that the second orifice not only exhausted the water of the first orifice easily—due to the diminished area of the jet at its high velocity—but it acted also as an air ejector, creating a partial vacuum between the two orifices and causing the greater pressure drop through the first orifice.

A change of distance between the two orifices does not affect their discharge after a certain point is reached, as is shown by the horizontal parts of the various curves in Fig. 2 and the constant pressure drop through the orifices as in Fig. 3 after a distance of 1 in. or more is reached, depending on the areas of the orifices and the pressure head. When the distance between two orifices is such that the velocity of flow is uniform throughout the cross

section of the pipe and the velocity of approach is negligible, then, according to the experimental results obtained, the formula for the discharge through orifices in series is:

$$Q = \frac{(K_1 \times K_2)(A_1 + A_2)\sqrt{2gh}}{2}$$

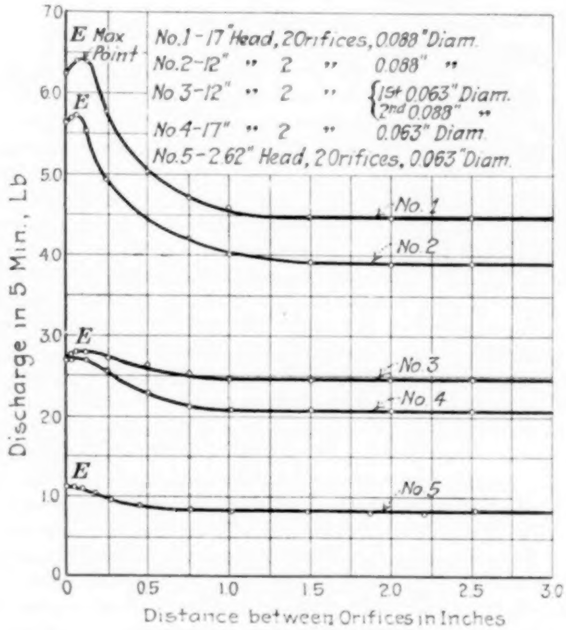


Fig. 2 Curves Showing Effect of Varying Distance between Two Orifices in Series on Discharge under a Constant Pressure Head

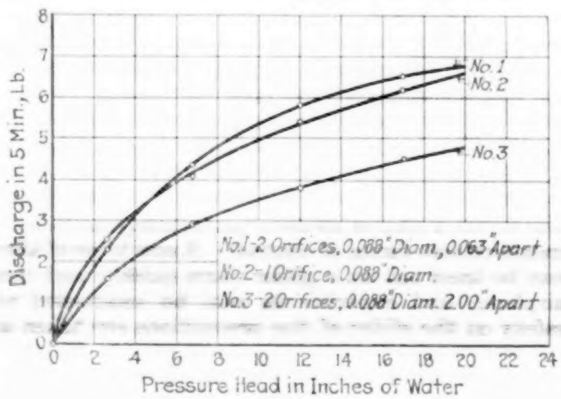


Fig. 4 Discharge Curves of a Single Orifice and of Two Orifices in Series, All Orifices Being of the Same Size

where Q = discharge in cu. ft. per sec.
K_1 = efflux coefficient of first orifice
K_2 = efflux coefficient of second orifice
A_1 = area of first orifice
A_2 = area of second orifice
$2gh$ = velocity corresponding to the pressure head.

Curve No. 3 in Fig. 4 is the discharge curve of two orifices each having a diameter of 0.088 in. and separated 2.00 in., which distance places them on the straight-line portion of the discharge-distance curves of Fig. 2 or of the pressure-distance curves of Fig. 3. Curve No. 1 in Fig. 1 is for the same two orifices, but they are placed so as to give maximum discharge corresponding to points under the letter E in Fig. 2; while curve No. 3 is plotted for a single orifice 0.088 in. in diameter. Curves Nos. 1 and 2 intersect when the value of the pressure head is 3.9 in., at which head these orifices will discharge the same amount in series as if discharging singly. Below 3.90 in. pressure head a good contracted jet is not formed and the two orifices will always discharge less than one will by itself, regardless of the placing of the two orifices in series. This does not hold true, however, when the pressure head is greater; for example, the tests show that above 3.90 in. head the two orifices in series can be so spaced that their discharge will be larger than the discharge from one orifice alone. The distance between

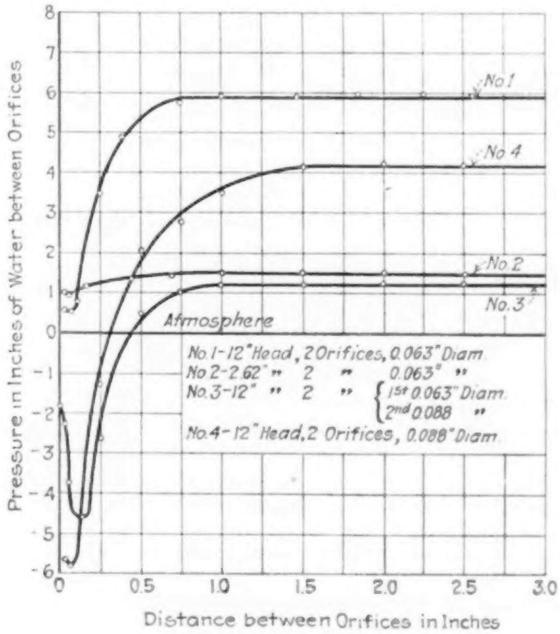


Fig. 3 Curves Showing Pressure between Two Orifices in Series Plotted against Distance between Orifices, Pressure Head Constant

the two orifices giving the maximum discharge is, according to test results, 70 per cent of the orifice diameter. The ratio of the discharge from two 0.088-in.-diameter orifices in series so spaced as to give maximum discharge and under a sufficient pressure head, to the discharge from a single orifice of the same diameter is 1.04.

H. W. Dietart.

Houston, Tex.

TEST CODE FOR FEEDWATER HEATERS

(Continued from page 760)

(36) Barometer reading .... in. Hg.
(37) Room temperature .... deg. fahr.
(38) Quantity of water through heater .... lb. per hr.
(39) Steam pressure in heater, gage ...... lb. per sq. in. or in. of mercury
(40) Steam temperature in heater by thermometer .... deg. fahr.
(41) Drain temperature .... deg. fahr.
(42) Vent temperatures by thermometer ....
(43) Steam temperature at inlet by thermometer ....
(44) Inlet water temperature .... deg. fahr.
(45) Outlet water temperature .... deg. fahr.
(46) Weight of steam used .... lb. per hr.
(47) Inlet water pressure, gage .... lb. per sq. in.
(48) Outlet water pressure, gage .... lb. per sq. in.
(49) Water-pressure drop by differential mercury column ....

Computed and Deduced Results

(50) Velocity of water in tube .... ft. per sec.
(51) Steam temperature in heater corresponding to absolute steam pressure .... deg. fahr.
(52) Quality of steam supplied to heater, per cent moisture or degrees of superheat ....
(53) Temperature rise .... deg. fahr.
(54) Logarithmic heat transfer coefficient, B.t.u. per hour per sq. ft. of surface, per degree of logarithmic mean temperature difference (Par. 10) ....
(55) Weight of steam theoretically required per lb. of water, computed from heat balance .... lb.
(56) Weight of steam used per lb. of water .... lb.
(57) Water-pressure drop in heater .... lb. per sq. in.
(58) Steam lost up stack .... lb. per hr.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

Sailplaning

THE extraordinary flights carried out during the past summer by Hentzen and other German pilots, together with the success obtained by certain French experimenters during the summer's competitions and more especially after their close, have naturally and properly aroused great interest in America. There is direct and inherent interest in a motorless flight lasting two hours or more, but there has been manifest also a hope that these developments will prove of immediate practical utility in decreasing the power required for flight and in making commercial air transport safer and more certain than it has been in the past. Some enthusiasts have already gone so far as to predict that engines will be altogether dispensed with and that sailplanes will cruise across deserts and oceans without the expenditure of any power, an achievement which is theoretically possible but which would be much closer to perpetual motion than most engineers have ever expected to get.

Edward P. Warner

Having been a witness of both the French and German soaring meets, the writer has no hesitation in declaring his own belief that the day when engines can be dispensed with is far away, and, indeed, that there is no real indication of its approach. The records of the past summer are important, but they do not herald the advent of motorless cross-country flights carried out on regular schedule. They were not accomplished by magic, and they involve no violation of the familiar laws of mechanics.

The real significance of the flights carried out from the Wasserkuppe and La Taupe lies in other directions, and it seems to lie first of all in the field of aerological research. For many years the structure of the atmosphere has been debated, and in particular there has been great argument as to the magnitude of the vertical motions of the air and as to the localities where such motions were likely to occur. Now, for the first time, ascending currents are being used for the support of aircraft and the pilots are of necessity gathering information concerning them by the slow but certain process of trial. The information is all useful, however, whatever the purpose for which it was gathered or the method employed. If airplanes are to fly safely with much less reserve power than they now possess it will be necessary greatly to increase our knowledge of the structure of the atmosphere and of the nature of the conditions which may have to be met when flying over unfavorable country such as the mountainous regions where the gliding experiments have been carried out. The continuance of the work with gliders furnishes an incentive and to some extent a means for the acquisition of such knowledge.

The second element of importance in the tests has to do with the training of pilots. They furnish a means of keeping in practice at moderate expense, and they lead to the development of a delicacy of control perhaps even superior to that required for the satisfactory handling of a powered airplane. It is for advanced training only, however, that the glider should be counted on. Despite the fact that a few German students have learned to fly gliders without ever having been in an airplane, such procedure cannot be recommended as either economical or safe for the ordinary individual. Except for landing, which is facilitated by the low ground speed of the gliders, a glider is harder to fly successfully than an ordinary airplane, and the sport is not one to be undertaken lightly by schoolboys. Conducted with due precautions it forms a useful element in the training of a pilot, and Lieutenant Thoret, one of the oldest and best known of French Army fliers, has gone so far as to recommend that every military pilot should undergo a course of instruction in gliders before his studies are considered complete.

Third, and most interesting to engineers, there arises the question of the effect of the glider experiments on the design and construction of airplanes of the future. That effect will probably be small. The designs of the most successful gliders incorporate little that differs from the standard airplane practice, at least so far as externals are concerned. The details of construction show some changes from what is conventional in powered machines because of the necessity of building very lightly. In the airplane, carrying a loading of six pounds or more for every square foot of wing surface, the materials can naturally be heavier and the assembly more solid than in the gliders which are loaded about two pounds per square foot. The constructional practice developed for use in the gliders will of course be available for light airplanes if, as seems probable, there arises in the future a demand for sporting machines with very low power and light wing loading.

Finally, the glider must be considered as an instrument of aeronautical research. Its potentialities in that capacity have often been overestimated, and there is no probability that it will supersede the wind tunnel, as some overenthusiastic writers have suggested, but it has a field of its own, particularly in connection with experiments on new forms of control. A new type of aileron, for example, can be tried out on a glider more quickly and cheaply than on an airplane, and experiments can be conducted with comparative safety on the glider of due precautions are taken and no attempts made to break records. One of the most interesting features of the German meet this summer was the originality displayed in the means provided for controlling some of the competing machines. While the majority employed the full complement of airplane controls, there were a few who dispensed with the rudder, securing directional as well as lateral control through the ailerons or through tilting the wing tips, and several others had no movable elevator, the longitudinal control being cared for by tilting the wings as a whole to a different angle of attack. Any such radical change of course requires that the pilot learn to fly all over again, and self-instruction, which must be the rule with a wholly original type of machine because no teachers are available, is no more difficult on a glider than on an airplane.

In summary, it may be said that, great as is the interest of the glider competitions, it is doubtful if they bring results of sufficient importance to justify the diversion of any considerable part of our energies from engine-driven aircraft to the motorless type. The glider should be used for the purposes which it is best fitted to serve, but it should be used with a clear understanding of its limitations and without imagining that its development will make it possible to slacken the effort applied to the improvement of the present-day airplane.

Edward P. Warner.[1]

[1] Professor of Aeronautical Engineering, Massachusetts Institute of Technology.

Industrial Development in the Orient

[To gain a better understanding of hydroelectric power developments in Japan, Mr. W. M. White, manager and chief engineer of the hydraulic department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., spent the latter half of 1921 in the Orient, visiting Formosa, China, Korea and Manchuria, as well as Japan. In the following article Mr. White has set forth some of his impressions of industrial possibilities in these countries.—Editor.]


W. M. White

JAPAN is advance agent of our civilization to the peoples of the Orient; she has made greater progress in the arts and sciences of our western civilization than all of the other oriental peoples put together. Her interpretation of our arts and sciences is being impressed upon Korea and Formosa and her influence is extending into Manchuria and China. Observations, inquiries, and studies made in Korea and Formosa, convinced the writer that Japan is doing a good and needed work along certain lines.

Formosa, particularly, has made great advancement in the ways of civilized peoples since 1895, at which time the island was ceded to Japan at the termination of Chino-Japanese War. The Japanese have destroyed the feudal walls surrounding the ancient capital Taihoku and put city street railways in their stead. Taihoku has spread far beyond the confines of the old walls, and instead of the ancient, dreary, shut-in, congested town, there has arisen, under Japanese domination, a city of 100,000 population, with many of our modern conveniences. Railways have been built along the western side of the island from Keelung on the north to Takao at the south.

The Japanese support and maintain a large army, which is engaged in the subjugation, pacification, reclamation, education and civilization of the savage aboriginal head-hunting tribes which infest the camphor-wooded sides of the high mountains. Only about one-third of the island yet remains savage territory. The writer visited the border line of the recently subjugated territory where work was in progress upon a water-power plant near the outlet of Lake Jitsugetsatu. The waters of the Jitsugetsatu River are to be diverted into Lake Jitsugetsatu by means of a tunnel fifteen feet in diameter and about ten miles long. A dam which is to be located at the outlet of the lake will impound the waters to an additional height of 85 ft. Another tunnel leads from the lake three miles to a bluff above the Suirikei, affording a head of 1000 ft. The jungle has been cleared away for the pipe lines. The power house is to contain five units each of 30,000 hp. Transmission lines run to both the north and south ends of Formosa, forming trunk lines which will feed every important city on the island. When one considers that there is now utilized in Formosa less than 15,000 electrical horsepower, one realizes that this is a venturesome and bold stroke toward industrial development.

From the windows of a splendidly equipped railway train running from one end of Korea to the other, could be seen well-built highways—work done under Japanese direction—and mountain sides, which five years ago were bare, now covered with trees. thousands of which were planted by Koreans in lieu of the payment of taxes.

The coal deposit at Fushun is twenty miles in length, one mile in width and, at one place, 476 ft. in thickness. American-made electric locomotives handle the cars going about the mines, on railway tracks of American standard gage. The writer saw coal being mined in an open pit with the aid of American steam shovels, the excavated coal being dumped into gondola cars. At Ashan there were two blast furnaces, one of which was in operation at part capacity, producing 250 tons of pig iron per day. There is, however, lack of sufficient high-grade ore to make this project successful, although the deposits of low-grade ore are enormous in this vicinity.

Japan is mountainous, there being a possible tillable area of only seventeen per cent, so that she must look to the field of mechanical arts for the occupation of her rapidly growing population. The Japanese are apparently realizing that cheap power is vital to the development of their country, for within the last decade one million and a quarter of her possible eight million water horse-power has been developed. High-tension transmission lines radiate from Tokyo in nearly every direction to hydroelectric plants located within a radius of about one hundred miles. One notable development just being undertaken is that on the Shanano River, the waters of which are to be diverted, carried through a tunnel of 28 ft., finished diameter for a distance of fifteen miles to a forebay, the elevation of which will be 450 ft. above the river level. Hydraulic turbines will utilize the available water and will produce about 300,000 hp.

W. M. White.

A.S.M.E. Annual Meeting to be Supplemented by Power Exposition

THE combination of a strong technical program and an exposition of engineering apparatus will undoubtedly prove to be the attraction that will bring members of the A.S.M.E. to New York during the first week of December in greater numbers than ever before. The Forty-third Annual Meeting of The American Society of Mechanical Engineers, which will open on December 4, will comprise twenty-two sessions dealing with both theory and practice in the various branches of mechanical engineering. This meeting will last four days and will be followed by the National Exposition of Power and Mechanical Engineering, to be held at the Grand Central Palace, at which apparatus and materials of interest to mechanical engineers will be exhibited. Fundamentally the great underlying idea of both the A.S.M.E. Annual Meeting and the Exposition is that of disseminating information which will contribute to the development of the art and science of mechanical engineering. The discussion of the technical papers presented at the Annual Meeting forms a factor of very real importance in this development; and the addition this year of the educational effect of an exposition in which machines and apparatus may be carefully studied, will undoubtedly result in an increased interest being taken in its furtherance.

Members of the A.S.M.E. will be admitted to the Exposition upon display of their badges or membership cards.

The program for the Annual Meeting will not only treat of technical subjects, but will emphasize a number of broad considerations in which engineers will be vitally interested. A joint session will be held on December 6 in the evening with the American Economic Association, at which Dr. W. C. Mitchell, of the National Bureau of Economic Research, will deliver an address on the subject, Making Money and Making Goods. He will be followed by E. M. Herr, President of the Westinghouse Electric and Manufacturing Company, who will talk on The Human Problem in Industry. The broad economic phases of engineering which these two addresses will broach will be discussed under the leadership of Prof. H. R. Seager, President of the American Economic Association; Dean Dexter S. Kimball, President of the A.S.M.E.; and H. F. Loree, President of the Delaware and Hudson Railroad Company.

Further joint sessions with the American Society of Safety Engineers and the American Society of Refrigerating Engineers are under consideration.

The Standing Committee on Training for the Industries will present a Committee Report on Industrial Training which will speak authoritatively in the matter of correspondence work in extension schools, industrial training in schools, and industrial training within the works. The Committee in charge of this Report consists of W. W. Nichols, Chairman, Dr. Ira N. Hollis, D. C. Jackson, Dean R. L. Sackett, Prof. C. R. Richards and J. C. Spence; J. A. Moyer is coöperating in its preparation. The Standing Committees on Research and Standardization are also preparing programs, and the Professional Divisions on Aeronautics, Forest Products, Fuels, Gas Power, Machine Shop Practice, Management, Materials Handling, Power, Ordnance, Railroads and Textiles, will be represented at appropriate sessions. A detailed statement regarding the program will be made in the November 7 issue of *A.S.M.E. News*.

"Opportunity"

THE wireless apparatus which was supposed to carry President Kimball's words from East Springfield to the dining room at the top of Mt. Tom was not working very well. The toastmaster said, however, that he got one word out of it very distinctly—"opportunity."

And that is the most important and significant word in President Kimball's address.[1] No man can be sure about the degree of success he will attain in his chosen calling, but he can be absolutely sure that his attainments will not be very great if he denies himself opportunities for development; and such opportunities for the engineer are to be found in Professional Society membership.

True there are many who find that to be listed as a member of the A.S.M.E., to wear its insignia and to receive its publications are sufficient for them, but when these are not considered sufficient and the question is asked, "What else does (or can) the Society do for me?" then the answer must be, "Nothing except as you participate in its activities."

It is in these activities that self-development is stimulated and prompted, and from no other source can these super-added benefits be derived. A great number of qualities and conditions must contribute to success in life. One of the essential things is "opportunity." Real success cannot be bestowed, it must be attained by proper use of opportunities, and this applies to the engineering fields as well as to all other departments of human activity.

F. J. MILLER.[2]

Dr. Giolitti Favors World Union of Engineers

AN APPEAL for coördination of the iron and steel industries of the United States and Italy was made by Dr. Federico Giolitti at a luncheon given in his honor at the Bankers' Club, New York City, on September 26, by the Iron and Steel Committee of the American Institute of Mining and Metallurgical Engineers.

Dr. Giolitti, head of the Ansaldo works at Genoa and a leading Italian metallurgist, has recently toured America speaking for the internationalization of industrial effort through the engineering profession and the world union of engineers to promote peace.

Dr. Giolitti pictured Italy as a rising industrial power which is making great progress in the manufacture of steel and iron, especially in electric steel and iron. High-grade pig iron, he stated, is being turned out cheaper than elsewhere, steel plants are being constructed, and lakes are being built for purposes of irrigation, with power as a by-product. He felt that Italy and the United States could work together in the iron and steel industry to good advantage, the former supplying labor and the latter fuel and raw materials.

Other speakers at the luncheon were M. Gaston Liebert, consul general of France; Edward D. Adams, vice-chairman of the Engineering Foundation, and Charles F. Rand, chairman of the Foundation, who presided; John W. Lieb, past-president of the A.S.M.E.; Bradley Stoughton, formerly secretary of the A.I.M.E.; Dr. Rossi, Italian consul; and Dr. A. R. Ledoux, past-president of the A.I.M.E.

International Engineering Congress in Brazil

Representatives of Leading Engineering Societies, Convened at Rio de Janeiro, September 17 to 30, Study Common Problems of Conservation and Utilization of Natural Resources

SEVEN years ago the mecca for engineers was San Francisco, where they might attend not only the International Engineering Congress but also the Panama-Pacific International Exposition at San Francisco and the Panama-California Exposition at San Diego. This year, again, the profession has been afforded a unique opportunity, that of attending another international engineering congress, held in Rio de Janeiro in conjunction with the Brazilian Centennial Exposition. The magnitude of industrial and particularly engineering developments during these past seven years, coupled with the growing recognition of the similarity of the engineering problems in South and North America, makes both events important to engineers.

Until recently Latin-America, being more familiar with the French than with the English language, has naturally turned to French engineering text-books and magazines and has followed the engineering methods and standards of France. But with the increasing realization that Latin-America faced engineering problems more like those of the United States than those of the smaller and more fully developed France, our text-books and periodicals have been in greater demand and the United States is coming to be used more generally as an engineering model.

It is fitting, therefore, that this country should contribute in every possible manner to the success of what promises to be the largest exposition ever held south of the equator, and particularly to that of an exposition celebrating the independence of Brazil, a country which has already participated in eight expositions in the United States. The appropriation of $1,000,000 for the exposition made by Congress provides for many official exhibits showing the progress made in science, industry, and commerce. These and a large number of private exhibits will acquaint the people of South America with practically every phase of our industries, while the South American exhibits, in turn, will express the economical and social progress of that continent during the last century.

The International Engineering Congress, which opened on September 17 and closed September 30, was conceived to "study and discuss the solution of certain problems interesting various countries." The following list of sections into which the work of the congress was divided show more definitely just what problems were considered:

1 Overland, maritime, fluvial, and aerial transportation; the Pan-American railway, practical means of its construction
2 Iron metallurgy
3 Fuels
4 Hydraulic power, its utilization as motive power
5 Sanitation, dams, and irrigation
5 Maritime and fluvial ports, their regime and relations with international navigation
7 Machinery for agricultural and industrial purposes
8 Standardizing of statistical methods in ports and railways.

ORGANIZATION OF THE CONGRESS

The organization of the Congress was the work of the Club de Engenharia of Rio de Janeiro, which for forty-two years has devoted its energies exclusively to the studies and development of engineering and industrial problems in its own country. The officers of the Executive Committee of the Congress were: Dr. Ozorio de Almeida, president; Dr. Daniel Herninger, vice president; Dr. Alvaro Niemayer, secretary; and Commander Saturnino Gomes, treasurer. Official invitations were sent out through the Brazilian government to engineering societies in mechanical, electrical, mining, and civil engineering fields. In the United States a joint committee of the four national societies was appointed to arrange for their participation in the Congress. The members of this committee were:

A.S.C.E., I. W. McConnell, Fred Lavis, V. L. Havens, P. W. Henry, M. H. Freeman, and J. H. Dunlap
A.I.M.E., T. T. Read, G. W. Tower, and F. F. Sharpless
A.S.M.E., P. H. Thomas, Maurice Coster, C. W. Rice, and D. P. Robinson
A.I.E.E., Maurice Coster, F. L. Hutchinson, and P. H. Thomas

A similar committee was appointed in South America, the personnel of which was:

A.S.C.E., H. B. Pond, W. T. Webb, Walter Charnley, C. H. Crawford, A. W. Billings, and W. G. McConnell
A.I.M.E., M. A. R. Lisboa, E. P. DeLiveira, A. S. Barboza, and H. W. Williams
A.S.M.E., A. S. Barboza, A. W. Billings, and W. A. Haile
A.I.E.E., C. M. Mauseau, E. A. Sturgis, C. P. Braconnot, W. V. B. Vandyck, and A. W. Billings

Mr. Arrojado, Mr. D. Chisholm and Mr. Ernest Havens also served with this committee. The full list of Engineering societies

[1] This address appears in full on page 724 of this issue.
[2] Acting Secretary of the A.S.M.E.

and organizations of the United States represented and their delegates follows:

A.S.C.E., A. W. K. Billings, Walter Charnley, C. W. Comstock, P. B. Easterbrooks, Verne L. Havens, L. C. Heilbronner, Fred Lavis, W. G. McConnell, A. A. Northrop, C. W. Rice, A. A. Fereira, Geo. Ribeiro, Geo. Schobinger, Victor da Silva Freire, T. P. Stevenson, A. Y. Sundstrom, and B. S. Thayer

A.I.M.E., T. T. Read, C. W. Rice and D. Chisholm

A.S.M.E., C. W. Rice, C. H. Crawford, Percy J. Allen, A. S. Barbosa, J. H. Bowden, A. H. Dick, A. P. da Silva, Herman Greenwood, W. A. Haile, A. A. Locazette, S. M. Lambert, E. B. Linton, E. G. Muller, A. Pachon, José de Assis Ribeiro, Arthur Rouband, and C. E. B. Sylvain

A.I.E.E., A. W. K. Billings, F. J. W. Luck, C. M. Mauseau, J. H. Payne, C. W. Rice, F. H. Shepard, Edwin A. Sturgis, and William V. Van Dyck

F.A.E.S., Engineering Foundation, and United Engineering Societies, V. L. Havens, T. T. Read, and C. W. Rice

American Railway Engineering Association, C. H. Crawford, and R. C. Crocker

American Society for Testing Materials, W. E. Emley

American Association of State Highway Officials, Clifford Schoemaker

Engineering Institute of Canada, Prof. E. O. Temple Piers and C. W. Rice

American Engineering Standards Committee, American Water Works Association, John Fritz Medal Board of Award, and National Research Council, C. W. Rice

Mr. Rice, honorary vice-president and secretary of the A.S.M.E. was also appointed personal representative of the engineers in this country to continue from Rio de Janerio with messages to the various engineering societies in other cities of South America.

The Technical Program

As shown by the list of sections into which the work of the Congress was divided, the technical program was confined to practical problems of conservation and utilization of natural resources. The accompanying list gives the titles and authors of the papers presented, by the four national engineering societies of the United States, many of which were illustrated with slides and photographs.

High-Tonnage Blasting, Dr. W. O. Snelling, Trojan Powder Co., Allentown, Pa.

Utilization of Low-Grade Fuels with Seymour Pulverizers, with film, Erie City Iron Works, Erie, Pa.

Electrical Apparatus for High-Tension Power Transmission, Stephen Q. Hayes

Economic Possibilities in the Use of the Low-Grade Fuels of South and Central America with Special Reference to Locomotive Requirements, Howard P. Quick, New York, N. Y.

Some of the Engineering and Construction Problems of the Panama Canal, with slides, S. B. Williamson, construction civil engineer, Guggenheim Bros., New York, N. Y.

Mammouth Coffer Dam for Pier Construction in New York Harbor, with slides, Charles W. Staniford, New York, N. Y.

The Design of Masonry Dams, with slides, Edward Wegmann, New York, N. Y.

Technique of Radio Broadcasting, with slides, S. M. Kintner, Westinghouse Elec. & Mfg. Co.

High-Head Hydroelectric Development in the Mountains of California, with film, A. A. Northrop, Stone & Webster, Inc., Boston, Mass.

Long-Distance Telephony in the United States of America, with slides and photographs, Bancroft Gherardi, vice-president and chief engineer, and H. S. Osborne, transmission engineer, American Telephone and Telegraph Co.

Developments of Electric Drives for Cotton Mills in the United States, with slides, C. N. Johnson, general engineer, Westinghouse Elec. & Mfg. Co.

Some Service Records of Electric Locomotives and Motor Cars in American Heavy-Traction Service, with slides and photographs, Homer K. Smith, railway engineer, Westinghouse Elec. & Mfg. Co.

Static Transformers for Pressures of 150,000 Volts or Higher, Walter S. Moody

A New Electric Furnace for Brass, Bronze and Copper, J. Murray Weed, power and mining engineering department, General Electric Co.

Factors Limiting the Voltage of Long-Distance Transmission Lines, F. W. Peek, Jr., General Electric Co.

Development in Hydroelectric Practice, T. A. E. Belt, General Electric Co.

Large High-Voltage Oil-Circuit Breakers, E. M. Hewlett, engineer, switchboard department, General Electric Co.

High-Voltage Long-Distance Transmission of Power, B. Nikiforoff, lighting engineering department, General Electric Co.

Impressions of the Cotton Textile Mills in the United States, R. L. Pamplona, General Electric Co.

The Present Status of the Electric Furnace for the Iron and Steel Industry, John A. Seede, General Electric Co.

Concrete Piles and Concrete Piling Construction, with slides, Maxwell M. Upson, Raymond Concrete Pile Co., New York, N. Y.

Report on the Development of the Cachoeria Paulo Affonso, Brazil, Charles O. Lenz, New York, N. Y.

An Outline of the Development of Excavating Machinery, with slides, Bucyrus Company, New York, N. Y.

Two other films, in addition to those shown illustrating papers, were also run, one entitled Coal is King, by the Diamond Power Specialty Co., New York, N. Y. and one entitled Pit River Development, by the Pacific Gas & Elec. Co., San Francisco, Cal.

In view of the need for all engineers to work together for the solution of the principal economic problems of the day the importance of this congress cannot be overestimated. The direct interchanging of information, the discussion of mutual problems and the establishment of personal contacts are essential factors in establishing a world union of engineers for "organizing and directing men and controlling the forces and materials of nature for the benefit of the human race."

Dr. Stratton Elected President of Massachusetts Institute of Technology

The Massachusetts Institute of Technology is to be congratulated on having secured for president Dr. Samuel Wesley Stratton, for twenty-one years director of the Bureau of Standards at Washington. Dr. Ernest Fox Nichols, elected president in 1921 to succeed Dr. Richard C. MacLaurin, who died in January, 1920, was forced by ill health to resign without having served in office. A committee of faculty and corporation members has carried on the administrative work.

Dr. Stratton was born in Litchfield, Ill., in 1861, and was graduated in 1884 from the University of Illinois, where he later became professor of physics and electrical engineering. From 1892 to 1901 he was with the physics department of the University of Chicago.

As head of the Bureau of Standards he has built up from a small office of weights and measures employing three or four persons a bureau which occupies a dozen buildings and has a staff of more than 900 employes. The Bureau is closely aligned with the industries of the country, aiding them in research work and development of precision of method.

Dr. Stratton has received the honorary degree of Doctor of Engineering from the University of Illinois and that of Doctor of Science from the Western University of Pennsylvania, the University of Cambridge and from Yale. He was made a Chevalier of the Legion of Honor in 1909.

In the war with Spain he served as a Lieutenant in the Navy. During the World War he was a member of the Interdepartmental Board of the Council of National Defense and of the National Advisory Committee for Aeronautics.

Herbert Hoover, commenting on the resignation of Dr. Stratton, said:

> The loss of Dr. Stratton as head of the Bureau of Standards is a real national loss. He has built up that service from a bureau devoted to scientific determination of weights and measurements to a great physical laboratory coöperating with American industry and commerce in the solution of many problems of enormous value in industry which the commercial laboratories of the country, from lack of equipment and personnel, have been unable to undertake.

Dr. Stratton will take up his duties at M.I.T. on January 1, 1923.

An Index to Technical Bibliographies

In assisting the extension of the services of the Engineering Societies Library Mechanical Engineering during recent years has recognized both a duty and an opportunity. The publication of book reviews and of The Engineering Index has been in accord with the general policy of putting the unequalled facilities of this great technical library at the disposal of the entire profession.

The question now arises as to the extent to which an index of bibliographies, such as is printed on page 774 of this issue, would be used. Owing to the fact that there are in print comparatively few bibliographies on technical subjects the Library is frequently asked to compile them, for which service a charge of two dollars an hour is made. An index to bibliographies to be found in current technical literature ought, therefore, to be of real value and if the demand warrants it, such items will be printed in Mechanical Engineering as frequently as available.

Engineering and Industrial Standardization

Automotive-Engine Crankcase Oils

One of the most important subjects before the Standards Committee of the Society of Automotive Engineers is the establishing of definite specifications for different grades of engine-crankcase oil used by the several groups of the automotive industry.

The S.A.E. Lubricants Division was reorganized on an active basis in 1921 and work started on formulating practical specifications for crankcase oils, cup greases, transmission greases and other classes of lubricant. The work of the Federal Government, conducted by the Bureau of Mines in the Interdepartmental Committee on the Standardization of Petroleum Specifications, and the standard methods of testing adopted by the American Society for Testing Materials, have been considered carefully by the Division.

AUTOMOTIVE-ENGINE CRANKCASE OILS

(Tentative specifications, June 20, 1922)

General.—These specifications cover grades of petroleum oil for the lubrication of internal-combustion engines, except aircraft, and are not recommended for the lubrication of turbines.

Only refined petroleum oils without admixture of fatty oils, resins, soaps or other compounds not derived from crude petroleum will be considered.

Specification No.[1]	Flash point, min.	Fire point, min.	Viscosity, Saybolt Sec. 100 Deg. Fahr. Min.	Viscosity, Saybolt Sec. 100 Deg. Fahr. Max.	Viscosity, Saybolt Sec. 210 Deg. Fahr. Min.	Viscosity, Saybolt Sec. 210 Deg. Fahr. Max.	Color (NPA): darkest color allowed on mixture of oil and 50 per cent kerosene	Pour test, max.	Acidity, Mg. KOH per gram max.	Conradson carbon residue, per cent, max.	Corrosion test
20	325	365	180	220	42	–	5	35	0.15	0.20	Required for all grades
020	325	365	180	220	42	–	5	0	0.15	0.20	
30	335	380	270	330	44	–	5	40	0.15	0.30	
030	335	380	270	330	44	–	5	0	0.15	0.30	
40	345	390	360	440	46	–	5	45	0.15	0.40	
50	355	400	450	575	50	–	6	50	0.15	0.60	
60	360	–	–	–	55	65	–	55	0.15	0.80	
80	380	–	–	–	75	85	–	55	0.15	1.50	
95	390	–	–	–	90	100	–	55	0.15	1.75	
115	400	–	–	–	110	120	–	60	0.15	2.00	

[1] For Specifications Nos. 20 to 50, inclusive, the numbers indicate the first two figures of the average Saybolt viscosity in seconds at 100 deg. fahr. of the grades indicated. The first cipher in Specifications Nos. 020 and 030 indicates that the pour-test value of these two grades is zero. Nos. 60 to 115, inclusive, indicate the average Saybolt viscosity in seconds for these four grades at 210 deg. fahr.

Corrosion Test.—The following corrosion test shall not cause discoloration of copper strip: Place a clean piece of mechanically polished pure strip copper about 1/2 in. wide and 3 in. long, and 10 cc. of the oil to be tested, in a clean test-tube. Close the tube with a vented stopper and hold for 3 hr. at 212 deg. fahr Rinse the copper strip with sulphur-free acetone and compare it with a similar strip of freshly polished copper.

The accompanying table is the last revised specification proposed by the Lubricants Division as the result of the discussion at the Summer Meeting of the Society at White Sulphur Springs. The specifications are still open to revision and the Lubricants Division will appreciate constructive criticism, especially in regard to the identification of the different grades of oil by number instead of by name such as Light, Medium and Heavy.

A.S.M.E. Procedure Connected with the Approval and Adoption of Standards and Codes Prepared by the Society's Special Committees

Since its organization forty years ago The American Society of Mechanical Engineers has, through the activity of its technical committees, developed a large number of standards and codes of various kinds. The procedure followed in bringing about the coöperation of interested organizations and in informing all organizations and individuals of these activities has grown and developed through the years.

The present activities of the Constitution and By-Laws Committee together with the need which the Standing Committees on Research, Standardization, and Power Test Codes have felt for an exact, up-to-date statement of this procedure has prompted its preparation at this time. A draft approved by the Constitution and By-Laws Committee was presented to the A.S.M.E. Council at its September meeting and that body accepted and adopted it in the form which appears below.

Procedure Leading to Adoption of Special Reports, Standards or Codes

1 Preliminary Report, Standard or Code submitted to Secretary in duplicate, one copy signed by the members of the Committees with or without reservations (letter ballot equivalent to signature).

2 Preliminary Report, Standard or Code manifolded and distributed to a selected list including the Council for criticism and suggestion.

3 Preliminary Report referred back to Special Committee for revision in light of the criticisms and suggestions which are received.

4 Revised preliminary Report, Standard or Code submitted to the members of the Executive Committee of the Council.

5 Executive Committee of the Council votes: (*a*) to approve the printing of the Report; (*b*) to receive it without printing; (*c*) to refer back to special committee.

6 Printed in Mechanical Engineering for criticism and suggestion.

7 Presented for discussion at a regular Business Session of the Society or at a Public Hearing which may be held as part of the Spring or Annual Meetings. This open discussion must be fully advertised and all those within reason known to be interested or affected must be invited to attend, particularly the recognized national organizations of such persons. It will be conceded that when the outstanding national organizations of any industry or branch of engineering have been notified, such notice must be regarded as an adequate notice to all its members and companies, etc.

8 All written discussions and all records of the discussion at the Business Session or Public Hearing must be carefully considered by the Special Committee and the Report again revised where necessary.

9 Copies of the final draft of the Report are then submitted to the members of the Standing Committee concerned for review, to enable it to draft suitable recommendations to the Council.

10 Report submitted to the Council for final approval and adoption as to form and substance.

11 Report submitted to Publication Committee for consideration relative to printing in Transactions or publication as a separate pamphlet for general distribution.

A slightly modified procedure necessary when the standards and codes are developed by Sectional Committees for which the Society is sponsor or joint sponsor is now in the course of preparation through the combined action of the A.S.M.E. Standing Committees on Standardization, Safety Codes, Publication and Papers, Finance, Professional Divisions, Meetings and Program, Constitution and By-Laws, and Local Sections.

Functions and Method of Work of the A.S.M.E. Standardization Committee

One of the standing committees advisory to the Council of The American Society of Mechanical Engineers is that known as the A.S.M.E. Standardization Committee. Mr. E. C. Peck, of the Cleveland Twist Drill Company, Cleveland, Ohio, has been Chairman of this Committee for the past two years and it was through his initiative that a revised statement of the functions of his Committee was drafted and has now been approved by the A.S.M.E. Council.

Preliminary drafts of this statement were discussed informally during the Annual Meeting last December. It was then further revised and a copy mailed to each of the four hundred and more members of the Society serving on its Standards and Technical Committees. The comments and suggestions received from these members were carefully studied and a final revised draft prepared for transmittal to the Council. On September 25 this body voted to approve the statement as submitted and referred it to the Constitution and By-Laws Committee for inclusion in the Rules of the Society.

The following are the revised statements of duties of this Committee:

1 It shall be the duty of the Committee to collect and keep on file copies of all A.S.M.E. and other engineering, mechanical, and industrial standards and other data relating to standards which have been adopted in the United States and such foreign standards as can be obtained by exchange or otherwise.

2 It shall be the duty of the Committee to receive all proposals for the

development of standards, give the same consideration, and recommend a procedure to the Council.

3 It shall be the duty of the Committee to take the proper steps to initiate projects for standardization in the Society's field and communicate them to the Council.

4 It shall be the duty of the Committee, upon the acceptance of sponsorship by the Society for a given project under the rules of the American Engineering Standards Committee, to make sure that the scope of the work is clearly and accurately defined and that the name is suitable.

5 It shall be the duty of the Committee to assist the President and the Secretary in the organization of Sectional and Special Standards Committees by recommending A.S.M.E. members and others who are qualified to represent the A.S.M.E. on such committees.

6 It shall be the duty of the Committee to supply all Committees organized to develop dimensional standards copies of the procedure for such work approved by the Society and information regarding the facilities which are available for committee work. The Committee shall express its desire to assist these Committees in their work in so far as that is possible.

7 It shall be the duty of the Committee to secure periodically, for the information of the Council, a report of the status of the work on which each Special or Sectional Committee dealing with dimensional standards, is engaged.

8 It shall be the duty of the Committee to examine the reports of all Special or Sectional Committees dealing with dimensional standards and to make recommendations to the Council concerning them.

9 It shall be the duty of the Committee to expedite action on all matters pending between the A.E.S.C. and the A.S.M.E.

Two More Standard Specifications Submitted to A.E.S.C. under Rule R-4

During September the American Society for Testing Materials submitted to the American Engineering Standards Committee in due form its specification on the Methods of Testing Cotton Fabrics (D39-20) for approval as a Tentative American Standard. In its letter of transmittal it requested that it be designated as the Sponsor Body for the preparation of all specifications and methods of test for textile materials.

At about the same time this Society transmitted also its standard Methods of Test for Flash Point of Volatile Flammable Liquids (D56-21) for approval as Tentative American Standard under this same rule.

These two proposals are now before the members of the American Engineering Standards Committee, so that Dr. P. G. Agnew, Secretary of the Committee, will be glad to receive as much information as possible concerning the use and general approval of these two standards.

NEWS OF THE F.A.E.S.

F.A.E.S. Committee to Study Muscle Shoals Project

At a recent meeting of the Executive Board a resolution was passed authorizing the president to appoint a committee of engineers to make a thorough study of the Muscle Shoals project from an engineering standpoint, placing the facts in a clear and comprehensive manner before the public. The work of raising necessary funds has already been started and organizations which have studied the project have offered to place their data and statistical information in the hands of the committee. It is believed that the report of such a committee of disinterested engineers will be of great and possibly determinative value to the nation.

Secretary Wallace Makes Trip to Coast

Beginning with an address at the College of Engineering, Lincoln, Neb. on September 18, L. W. Wallace, executive secretary of the F.A.E.S., during the past month, has spoken in many of the important centers of the Pacific Coast and the Northwest. At Denver, on September 20, he addressed a joint meeting of constituent societies of the Federation held under the auspices of the Colorado Society of Engineers; he also spoke before the faculty and student bodies of the State School of Mines at Golden, and the University of Colorado at Boulder.

Mr. Wallace attended fall meetings of the A.I.M.E. and A.S.C.E. in San Francisco, discussing the aims and activities of the F.A.E.S. While in California he addressed the Joint Technical Societies of Los Angeles and the engineering students of the University of California. His itinerary for the return trip from the Coast included addresses before the Oregon Technical Council and Oregon Agricultural College, Portland, Ore., Associated Engineers of Spokane, the State College at Pullman, the University of Idaho, faculty and engineering students of State School of Mines, Butte, Mont., Chamber of Commerce, Columbus, Ohio, and industrial engineering students at Ohio State University.

Annual Meeting of American Engineering Council

The annual meeting of the American Engineering Council will be held Thursday and Friday, January 11 and 12, 1923. It will be preceded by a meeting of the Executive Board. The meetings will be held at the new headquarters of the F.A.E.S., 24 Jackson Place, Washington, D. C.

Report of Membership and Representation Committee

With the election of the Engineers' and Architects' Club of Louisville to membership in the F.A.E.S., the state and local societies in the Federation will be entitled to a total of twenty-two representatives on the American Engineering Council. As the national societies are now entitled to forty-four representatives, the ratio between the national and state will be two to one and their representation on the Executive Board will be sixteen for the national and eight for the state and local societies. The respective quotas of the national societies are as follows: A.I.E.E., five; A.I.M.E., three; A.S.M.E., five; and distributed among American Society of Safety Engineers, American Society of Agricultural Engineers, Society of Industrial Engineers, and American Institute of Chemical Engineers, three.

The division of districts for the year 1923 is as follows:

1 New York
2 Michigan, Minnesota, Wisconsin, Illinois, Indiana and Ohio
3 New England States
4 Maryland, Delaware, New Jersey, Pennsylvania, Virginia and West Virginia
5 North and South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Tennessee and Kentucky
6 Iowa, Missouri, Kansas, Nebraska, North and South Dakota, Wyoming, Colorado and Utah
7 Arkansas, Texas, Oklahoma, New Mexico and Arizona
8 Montana, Idaho, Washington, Oregon, Nevada and California

Special Meeting of Jurisdictional Board

The National Board for Jurisdictional Awards in the Building Industry held a special meeting in Cleveland on September 26 to consider the situation in that city and in Cincinnati, Pittsburgh, and other cities where difficulties have arisen because of independent agreements of contractors with the outlaw carpenter's union. All parties locally interested were invited to send delegates, and a general discussion took place on means for securing united and effective action toward the elimination of strikes.

British Engineering Joint Council

An important step in the movement toward international coöperation among engineers is the formation in England of an Engineering Joint Council of representatives of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, and the Institution of Electrical Engineers. Proposals for this union of British engineering bodies have been under consideration for some time, and particularly since the visit of American engineers to England last year, when great interest in the Federated American Engineering Societies was evidenced.

Among other objects, the joint council, as stated in the announcement of its formation, proposes to improve the status of engineers, to secure the better utilization of their services in the country's interests and the appointment of properly qualified individuals to responsible engineering positions, and to prevent the unnecessary duplication of activities.

The Engineering Joint Council will coöperate with the F.A.E.S. Committee on Affiliation with Engineering Societies outside of the United States in establishing direct contact between American and British engineers. This committee of the F.A.E.S. has already established contact with the engineering bodies of France, Italy, and Czechoslovakia.

NEWS OF OTHER SOCIETIES

American Chemical Society

Beginning on September 4 and extending through the week, the 64th annual convention of the American Chemical Society held at Pittsburgh included the presentation of a large number of papers under the auspices of various divisions and sections of the society and an all-day excursion to the Clairton by-product coke plant of the Carnegie Steel Co. and to the Monongahela, Pa., plant of the American Window Glass Co.

At the council meeting of the society announcement was made of an annual prize of $25,000 to be given by the Allied Chemical & Dye Corpn. to the chemist in the United States who, in the opinion of a proper committee, shall have done the most to advance the science of chemistry in the world. It is to be initiated in 1923.

Further announcement was made that the Chemical Foundation would annually donate $10,000 for defraying the publication expenses of the *Journal of Physical Chemistry* which will be published jointly by the Chemical Society (London) and the American Chemical Society.

Among the papers presented, one having a broad appeal both to the scientist and the industrialist was that by Thomas Midgley and T. A. Boyd on the Chemical Control of Gaseous Detonation, with Particular Reference to the Internal-Combustion Engine. Mr. Midgley has for some time been investigating the possibilities of eliminating "knocking" in engines by the addition of various chemical compounds to gasoline. He demonstrated, with a high-pressure gas engine, completely installed on the lecture platform, the detonating characteristics of various mixtures. Mr. Midgley stated however, that the full benefit of these compounds cannot be derived until gas engines have been redesigned to operate at higher compression. The increased knowledge of the theory of catalysis derived from these investigations is of great interest and importance from the scientific viewpoint.

A conference on world metric standardization was held at which some twenty-five organizations participating passed a resolution favoring the adoption of the metric system.

A symposium on automatic process control was held under the auspices of the Division of Industrial and Engineering Chemistry. Two papers were presented describing control devices employed in high-pressure testing of ammonia catalysts, a glass pressure gage consisting essentially of a glass diaphragm blown on the end of a tube and automatically recording pressure by means of a bent platinum wire contact, being an especially interesting device described by S. Karrer. The same division also presented several papers on corrosion, among which may be named one on the mechanism of the corrosion of iron and steel in natural waters and the calculation of specific rates of corrosion, by Robert E. Wilson, and one by F. N. Speller and V. V. Kendall on a new method of measuring corrosion under water and an investigation of the effect of velocity.

Two illustrated papers, one a consideration of the question, Do higher-sulphur fuels cause trouble in Diesel motors? and one on low-speed high-pressure friction tests with a Kingsbury machine were among the papers presented by the Section of Petroleum Chemistry.

Eleventh Annual Safety Congress

Following four days of "Safety First" campaigning by the Public Safety Bureau of the Detroit police department, the eleventh annual safety congress was held at Detroit, Mich., Aug. 28–Sept. 1, 1922. At the business meeting Marcus A. Dow, general safety agent of the New York Central lines, was elected president of the National Safety Council. W. H. Cameron was reappointed secretary.

There were several general sessions but in the main sectional meetings were held in order that each member might give his attention to that phase of safety engineering which was of particular interest to him. Among these were chemical, drop forge, education, engineering metals, mining, steam railroad, textile, and woodworking sections.

An industrial and public safety exhibit, an inspection trip to the Highland Park plant where 5000 Ford cars are made daily, and a mechanical safety exhibit were features of the meeting. Among the large number of papers presented were: Preventing Vapor and Gas explosions, F. J. Hoxie, engineer and special inspector, Associated Factory Mutual Fire Insurance Companies, Boston; Safety in Crane Repairing, E. E. Remington, assistant superintendent of maintenance, Ford Motor Co., Detroit; How to Lay Out a Woodworking Plant for Safety and Efficiency, B. A. Parks, Byron E. Parks & Son, Grand Rapids; Flywheel Explosions and Their Prevention, E. B. Tolstead, consulting engineer, Chicago; and Safe Practices in Acetylene and Oxygen Welding, H. S. Smith, Prest-O-Lite Company, New York.

Engineering Institute of Canada

Inspection trips to the hydroelectric works in the neighborhood of Winnipeg and the presentation of papers descriptive of the hydroelectrical development of the province of Manitoba were the chief features of the general professional meeting of the Engineering Institute of Canada held at Winnipeg, Sept. 5–7, 1922.

The Great Falls development of the Manitoba Power Company, which was described in a paper by F. H. Martin on the first day of the meeting, was visited by nearly 300 engineers on September 6. The initial development at Great Falls consists of two of the six units which provide for a total development of 168,000 hp. When operating under a head of 56 ft. and running at a speed of 138.5 r.p.m., the turbines, which are of the single-runner vertical-shaft diagonal or propeller type, will develop 28,000 hp. The generators, which will be of the vertical type, generating 3-phase 60-cycle alternating current at 11,000 volts, will have a capacity of 21,000 kva.

After leaving the Great Falls works, the engineers visited the civic plant of the city of Winnipeg at Point du Bois, about 78 miles from Winnipeg. This plant has a normal fall of 46 ft., a present capacity of 68,000 hp. and an ultimate capacity of 112,000 hp. This inspection trip was taken in connection with a paper on Extensions to the Hydroelectric System of the City of Winnipeg, presented by E. V. Caton on the previous day.

The sessions on the closing day of the convention included civil, geological and mechanical sections. Among the specific subjects discussed were turbines for the Great Falls development, disintegration of concrete by alkaline waters, fuel values of Alberta coal, and automatic grain-car unloaders.

Association of Iron and Steel Electrical Engineers

Iron and steel electrical engineers to the number of over 2000 came together at Cleveland, Ohio, September 11–14, 1922, for the sixteenth annual convention of the Association of Iron and Steel Electrical Engineers.

One of the features of the meeting was an exposition of mechanical and electrical apparatus of special interest to the iron and steel industry, trucks and tractors, handling equipment, and other steel-plant equipment contributed by over 85 companies.

At the business meeting, R. B. Gerhardt, electrical engineer for the Bethlehem Steel Co., Sparrows Point, Md., was elected president for the ensuing year. John F. Kelly, of Pittsburgh, will continue as secretary.

A report of electrical development showed that the electric drive is being adopted by a large number of rolling mills, with a tendency toward the use of direct-current motors supplied with power from motor-generators or rotary converters. Improvements in methods of production of electric energy and general power-station economies were also discussed in this report.

The motors and the control committees also submitted reports. Replies to a questionnaire on the use of anti-friction bearings sent out by the former committee to electrical engineers in 25 large steel plants, show that a high percentage of motor failures caused by oil could be eliminated by replacing ring oiler bearings by ball or roller bearings. The committee recommends standard anti-friction bearings. Control standardization was advocated in the report of the control committee.

Following his presentation of a paper on Generating Station Development, of which he was co-author with E. Pragst, David B. Rushmore was questioned as to the possibilities of the Ljungström steam turbine as an efficient prime mover. He believed it suitable for small-size units but on account of structural features, not practicable for large sizes.

Steam-boiler practice was the subject of several papers. Obtaining perfect combustion of gaseous fuel, the relative cost of large and small boilers per horsepower, the relation of heating surface to furnace width, types of stokers, the sectional-head boiler, amount of pressure, and the welding of pressure parts were among the points discussed.

D. M. Petty, electrical engineer for the Bethlehem Steel Co., So. Bethlehem, Pa., presented a paper entitled Internal-Combustion Engines for Power Generation in Steel Plants, in which he pointed out the advantages of the cast-steel cylinder over the cast-iron cylinder, and particularly the fact that cracks in the former can be welded. The use of blast-furnace gas was discussed by J. R. McDermott, chief engineer, Illinois Steel Co., and R. B. Gerhardt.

A paper by B. G. Lamme, chief engineer, Westinghouse Elec. & Mfg. Co., and W. Sykes, vice-president of the Canadian American Alloy Corpn., advocated steel-mill electrification as being highly efficient in that it is flexible, durable, economical, and easily maintained.

Charles P. Steinmetz, chief consulting engineer, General Electric Co., spoke on Improvement in Efficiency of Electric Power Supply, pointing out that the best economy requires the separation of power production from the industries it serves, although by-product energy should be conserved, preferably by interchanging power with the local section; i.e., the latter to take care of the by-product energy and supply the power needed by the industry.

A paper by Mr. Gerhardt on the Electrification of Steel-Plant Railroad Yards was well discussed. It was predicted that eventually all mill yards would be electrified.

American Electrochemical Society

The major part of the program of the annual convention of the American Electrochemical Society, held at Montreal September 21–23, 1922, was a symposium on electric industrial heating. Two full sessions were devoted to papers dealing largely with electric furnaces used in the ferrous and non-ferrous industries, with particular reference to the field of low-temperature work. The first session was introduced by a paper on the generation, propagation, and application to industrial processes of electric heat, by E. F. Collins, engineer for the General Electric Co., Schenectady, N. Y. Mr. Collins classified both the methods for the conversion of electric energy for industrial heating, and the industrial processes to which electric heat may be applied. He discussed the principles and laws governing various branches of his subject, illustrating his points with tables and charts, and closed with some remarks on the overall cost of electric heating.

An abstract of a paper on the principles of high-temperature furnace design, by E. L. Smalley, manager of the Electric Heating Apparatus Co., Newark, N. J., was presented by Wirt S. Scott, of the Westinghouse Elec. & Mfg. Co. The paper enumerated the attributes of electric furnaces which will give the highest quality of products at the lowest cost of operation and maintenance and with the greatest safety in operation at high temperatures.

The heat-treatment phase of the industry was presented in a paper entitled Some Electrical Properties of Alloys at High Temperatures, by M. A. Hunter and A. Jones, both of Rensselaer Polytechnic Institute.

Experiments being conducted at the Northwest Experiment Station of the Bureau of Mines, in coöperation with the University of Washington at Seattle, to determine the electrical resistivities of a number of granular-carbon resistor materials were discussed in an article prepared by Clyde E. Williams, metallurgist, U. S. Bureau of Mines, Seattle, Wash., and Gordon R. Shuck, professor of electrical engineering, University of Washington.

An illustrated lecture by Frank W. Brooke, engineer for Swindell & Co., Pittsburgh, discussed methods of economically handling materials in electric furnaces, describing recuperative furnaces involving the use of dummy furnaces, the counter-type of furnace, continuous furnaces, and the walking-beam type of heat-treating furnace.

The subject of heat-insulating materials for electric heating apparatus was treated in a paper by J. C. Woodson, and electric steam generators and their application by P. S. Gregory. A paper on Electric Annealing of Malleable Iron, by C. B. Gibson, of the Westinghouse Elec. & Mfg. Co. stated that few electric furnaces for the annealing of iron were in operation on a commercial scale. Two papers on electric melting furnaces were also presented at the industrial heating session.

Among the papers presented at other sessions of the convention were two on electrolytic iron, one considering the effect of heat treatment on the hardness and microstructure of electrolytically deposited iron and the other the preparation and the mechanical properties of vacuum-fused alloys of electrolytic iron with carbon and manganese, and two papers on the application of electric heat to the enameling and ceramic industries.

National Association of Stationary Engineers

With an attendance of some 1500, the National Association of Stationary Engineers held its fortieth annual convention at Des Moines, Ia., Sept. 11–15, 1922. A mechanical exposition was held in connection with this meeting, at which the latest developments in power-plant equipment were shown, over 100 firms contributing to the exhibition.

One of the principal discussions concerned a resolution of the Association's education committee proposing that the N.A.S.E. favor the passage of a national law requiring that all coal for delivery be accompanied by a certified copy of its proximate analysis and heat value, attached to the bill of lading. It was pointed out that the sale of inferior coal at top prices, particularly in times of shortage, would be prevented by such a law. The cost of making the analysis at the mine would be about two cents a ton.

One of the resolutions adopted at the business meeting called for the appointment of a committee of three to confer and coöperate with the A.S.M.E. in developing standard ammonia fittings.

Among the papers presented were those dealing with the causes of and remedies for dry rot in associations, by Charles H. Bromley, Richardson-Phenix Co., Fort Wayne, Ind., and with recent developments in feedwater treatment, by F. L. Dunham, of the Permutit Co. The latter outlines progress in water softening during the last twenty years, describing early intermittent softeners, the continuous softening process and the hot-process system employing the lime-soda treatment, and the zeolite process, the latest method.

Vice-President Frederick Felderman was elected president to succeed Richard W. Parry. Fred W. Raven, reappointed secretary, reported that membership in the association had passed the 22,000 mark.

New England Water Works Association

Among the phases of water-works problems considered at the 41st annual convention of the New England Water Works Association held at New Bedford, Mass., Sept. 12–15, 1922, were questions of pipe joints, service pipes, high-pressure fire systems, and water sanitation.

The New Bedford Water Department, in the spring of 1920, made tests of leadite and lead hydrotite joints on both 6-in. and 36-in. pipe, as the result of which leadite has been adopted and used in practically all the joints made since that time. Discussion on the paper in which Stephen H. Taylor, superintendent of the New Bedford works, described these tests, was also favorable to the use of leadite.

A paper by D. A. Heffernan, superintendent of the water department at Milton, Mass., and the discussion following condemned the use of relief and vacuum valves on domestic boilers because of corrosion, and considered other corrosion problems.

The water supplies of southeastern Massachusetts were described in three illustrated lectures given at the morning session on the second day of the convention, and the problems of several cities drawing upon the same source of supply outlined.

The effectiveness of the high-pressure fire system as shown in its use in New York during the last fourteen years was pointed out in a paper by G. W. Booth, of the National Board of Fire Underwriters, and the high-pressure system for Boston was described by F. A. McInnes, of the Public Works Department of that city.

In addition to the technical sessions there were excursions to various points of interest, including the Morse Twist Drill & Machine Co. and a manufacturers exhibit of water-works appliances and supplies.

Some Technical Bibliographies

THE following list of bibliographies on technical subjects has been compiled by Raymond N. Brown of the Engineering Societies Library, 29 West 39th St., New York, N. Y., where all of the publications named are to be found. The photostatic service as described in THE ENGINEERING INDEX may also be used in connection with this index. Attention is called to an editorial on page 769 in which mention is made of a further bibliographical service rendered by the Library.

Aeronautic Instruments. General Classification of Instruments and Problems, U. S. Natl. Advis. Comm. for Aeronautics, Report no. 125, Washington Gov't Ptg. Office, 1922, 22 pp.; bibliography, pp. 13–22. About 200 references beginning in 1892, arranged chronologically, more than half in German and French.

Carbon Black. Carbon Black, its Manufacture, Properties, and Uses, by R. O. Neal and G. St. J. Perrott, U. S. Bureau of Mines, Bull. no. 192; bibliography, pp. 80–91. About 220 references covering years 1844–1919 are grouped into periods and arranged by authors in each period. Most references are in English. Many patents included.

Carbon Steels. Hydrogen Decarburisation of Carbon Steels with Considerations on Related Phenomena, C. R. Austin, Iron & Steel Inst., Preprint of paper for Annual Meeting, May, 1922; bibliography, pp. 49–50. Thirty-nine references.

On Delayed Crystallisation in the Carbon Steels; the Formation of Pearlite, Troostite, and Martensite, A. F. Hallimond, Iron & Steel Inst., Preprint of paper for Annual Meeting, May, 1922; bibliography, pp. 19–20. Thirty-two references, for the most part in English.

Chromite. Deposits of Chromite in Eastern Oregon, L. G. Westgate, U. S. Geol. Survey, Bull. no. 725, pp. 37–65; bibliography, p. 38.

Dams. The Design and Construction of Dams, Edward Wegmann, John Wiley & Sons, Inc., New York, 1922, 7th ed.; bibliography pp. 529–546. Hundreds of references divided into sections for masonry dams, earth dams, movable dams, etc., and arranged chronologically in each section.

Directories. Trade and Class Directories Copyrighted in the U. S., Newark (N. J.), Public Library, Business Branch; Special Libraries, vol. 13, pp. 26–31, and 43–47. Lists under proper subject headings about 430 directories.

Distillation, Fractional. Elements of Fractional Distillation, C. S. Robinson, McGraw-Hill Book Co., Inc., New York, 1922; bibliography, pp. 198–200. Some 63 references covering years 1906–1920; one half of references are in German or French.

Electric Furnace. The Electric Furnace in the Iron Foundry, L. C. Judson and H. P. Martin, Amer. Electrochemical Soc., Preprint of paper no. 22, for Meeting, April, 1922, 10 pp. About 46 references to articles appearing during the last five years. Notes indicate the contents of each article.

Elevators, Electric. Electric Power Application to Passenger and Freight Elevators—Part IV, H. P. Reed, Jl. Amer. Inst. Elec. Engrs., vol. 41, pp. 152–164; bibliography, p. 164.

Engineering Education. A List of References on Engineering Education, Mrs. H. O. Norville, Bull. Univ. of Mo., School of Mines and Metallurgy, vol. 14, no. 1, pp. 89–100. About 160 references to periodicals, chiefly American, beginning with year 1912. Many items have descriptive notes.

Freight Terminals. Bibliography of Articles on Freight Terminals. Bull. Amer. Ry. Engrg. Assn., vol. 23, pp. 892–894. Lists 47 articles, most of which are in the Engrg. News-Rec. and Ry. Age.

Gears, Strength of. Gears, Jl. Soc. Automotive Engrs., vol. 11, p. 195–196; bibliography, p. 196. A selected list of 24 references.

Gelatin and Glue. The Evaluation of Gelatin and Glue, R. H. Bogue, Jl. of Ind. & Engrg. Chem., vol. 14, pp. 435–441; bibliography, pp. 440–441. About 25 references in German and 50 in English.

Heating and Ventilating Cost Data. Bibliography, Heat. & Vent. Mag., March, 1922, pp. 41–42. Fifteen references to the best books and articles.

House Organs. Bibliography and Selected References on House Organs, Nat. Elec. Light Assn., Bull. vol. 9, pp. 157–159. This is a list of some 130 articles about house organs.

Iron, Electrodeposition of. On the Electrodeposition of Iron, W. E. Hughes, Great Britian Dept. of Scientific & Industrial Research, Bull. no. 6, 1922, 50 pp.; bibliography, pp. 44–50. About 110 references in various languages, classified. Some descriptive notes.

Iron and Steel, Sulphur in. The Determination of Sulphur in Iron and Steel, H. B. Pulsifer, Chemical Publishing Co., Easton, Pa., 1922, 160 pp. Bibliography covering years 1797–1921. Some 300 references in many languages. Many items have long notes indicating contents of the articles. The arrangement is chronological but all authors cited are given in the index.

Iron and Steel Literature. Review of Iron and Steel Literature for 1921, E. H. McClelland, Blast Furnace and Steel Plant, vol. 10, pp. 4–8. "A classified list of the more important books, serials and trade publications."

Metals, Crystal Growth in. Crystal Growth in Metals, G. R. Fonda, Gen. Elec. Rev., vol. 25, pp. 305–315; bibliography, p. 315. Twenty-eight references, for the most part of recent date.

Metric System. The Metric System, H. H. B. Meyer. Special Libraries, vol. 13, pp. 1–16. About 350 references in many languages covering a long period of years. Most of the items are in the sections headed "Favorable" and "Opposed" to the metric system. Many entries have descriptive notes.

Mine Timber, Preservation of. Bibliography of Articles Relating to the Preservation of Mine Timber, R. R. Hornor. Reports of Investigations no. 2343, U. S. Bureau of Mines. April, 1922, 6 mimeographed pages. Sixty-four references from 1884 to 1921, mostly in American publications.

Motor Haulage. List of References on Motor-Truck Transportation, U. S. Library of Congress, Jan. 20, 1922, 19 mimeographed pp.

Nitrogen Fixation. Report on the Fixation and Utilization of Nitrogen, U. S. Ordnance Office, Nitrate Division, Washington Gov't Ptg. Office, 1922, 353 pp.; bibliography, pp. 343–353. About 125 references covering various methods of fixation of nitrogen. Includes articles in foreign publications. Most of the references fall in the period 1917–1921.

Oil Shale. Oil Shale Bibliography for 1921, Railroad Red Book, vol. 39, pp. 17–27.

Petroleum Refining. Petroleum Refining, Andrew Campbell, C. Griffin & Co., London, 1922, 297 pp.; bibliography, pp. 223–282. Many hundreds of references arranged alphabetically by subject. Includes translations of many foreign articles. The authors' names appear in the index of the volume.

Printing. Printing and Allied Industries, A List of Books and Periodicals, Newark (N. J.), Public Library, 1922, 17 pp.

Rails, Internal Fissures in. Bibliography, Bull. Amer. Ry. Engrg. Assn., vol. 23, pp. 658–667. About 75 references all in English, covering 1911 to 1920. Each reference is accompanied by a short abstract.

Railway Motors, Heating of. Heating of Railway Motors in Service and on Test-Floor Runs, G. E. Luke. Jl. Amer. Inst. Elec. Engrs., vol. 41, pp. 165–173; bibliography, p. 173. Ten references to articles in journals beginning with 1909.

Research. Research in Industry, A. P. M. Fleming and J. G. Pearce, Sir Isaac Pitman & Sons, Ltd., New York, 1922, 244 pp.; bibliography, pp. 221–236.

Safety Organization in Industry. Selected Bibliography, Safety, Bull. Safety Inst. of America, March, 1922, p. 75, 32 references.

Smoke Prevention. The Smoke Problem, O. P. Hood, Reports of Investigations no. 2323, U. S. Bureau of Mines, February, 1922, 5 mimeographed pages.

Sodium, Metallic. Metallic Sodium, H. E. Batsford, Chem. & Met. Engrg., vol. 26, pp. 888–894 and 932–935; bibliography pp. 933–935. Some 400 references in several languages arranged chronologically beginning with 1855.

Steel, Stainless. Bibliography in MECHANICAL ENGINEERING, vol. 44, p. 469, 22 references.

Train Control, Automatic Stop. Revised List of References on Automatic Train Control, U. S. Bureau of Railway Economics, 1922, 52 mimeographed pages. About 340 references. Part I consists of general discussions arranged chronologically beginning with 1903. Part II gives a list of descriptions of particular devices.

Trestles, Fireproofing. Bibliography, Bull. Amer. Ry. Engrg. Assn., vol. 23, pp. 725–726, 19 references.

Ventilation and Carbon Monoxide. The Physiological Principles Governing ventilation when the Air is Contaminated with Carbon Monoxide, Yandell Henderson and H. W. Haggard, Jl. of Indus. & Engrg. Chem., vol. 14, pp. 229–236; bibliography, p. 236. Sixteen references

Zinc Plating Solutions. A Study of the Throwing Power and Current Efficiency of Zinc Plating Solutions, W. G. Horsch and T. Fuwa, Amer. Electrochemical Soc., Preprint of paper no. 16 for Meeting, April, 1922. bibliography, p. 231. Thirty-five references beginning with 1894.

Zirconium. Zirconium and its Compounds, F. P. Venable. Chemical Catalog Co., New York, 1922; bibliography, pp. 149–169. Over 830 references to American and foreign publications covering half a century. Arranged alphabetically by author.

LIBRARY NOTES AND BOOK REVIEWS

American Fuels. By Raymond Foss Bacon and W. A. Hamor. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 2 vol., illus., diagrams, $12.

The editors of this volume have attempted to condense into a series of specially prepared chapters the fruits of the experience of specialists, and thus present an authoritative account of all American fuels of technical importance. It is intended to give informative summaries of sound practice and provide such information as will assist the engineer to decide upon the most suitable fuel to use or the changes to make in using fuel or heat in order to get the highest efficiency in plant operation.

Architectural Drawing. By Wooster Bard Field. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 10×12 in., 161 pp., illus., $4.

An effort has been made to provide those things which are of fundamental importance to the student in his initial study of the subject, together with a careful presentation of some of the important points that are usually left to be acquired during his office experience. The book should also be valuable to anyone who deals with architectural work.

Les Axiomes de la Mécanique. By Paul Painlevé. Gauthier-Villars et Cie, Paris, 1922. (Les Maitres de la Pensée Scientifique.) Paper, 5×7 in., 111 pp.

In this small book Professor Painlevé sets forth, with a minimum of mathematical terminology, the axioms of mechanics, as laid down by the founders of the science. From these he proceeds to a description of the modifications proposed by recent theories. His book is therefore not only a thorough study of the fundamental axioms of the subject but also an introduction to the theory of relativity.

Bearings and Bearing Metals. First edition. Industrial Press, New York, 1921. (Machinery's Dollar Books.) Paper, 6×9 in., 120 pp., illus., diagrams, $1.

A book of practical information upon plain bearings, in which the various types are shown and their suitability for various purposes explained. Information is also given on the composition and properties of bearing metals, the service to which they are adapted and proper methods of lubrication.

Beitrag zur Berechnung der Dampfturbinen auf Zeichenerischer Grundlage. By Erich Henne. Julius Springer, Berlin, 1922. (Forschungsarbeiten aud dem Gebiete des Ingenieurwesens. Heft 260.) Paper, 7×10 in., 58 pp., diagrams, chart, 20 marks.

Describes a simplified method of determining the dimensions of the stages of a turbine, for any given efficiency, by means of graphic charts. The charts are given in the book, with examples of their use. They are based upon the relation between the indicated efficiency, speed of revolution and the heat drop discovered by Loschge. By use of the charts, the author claims, much wearisome calculation can be avoided without any loss of accuracy.

Conservation of Natural Gas in Kentucky. By Willard Rouse Jillson. First edition. John P. Morton & Co., Louisville, Ky., 1922. Cloth, 5×8 in., 152 pp , illus., $2.

Dr. Jillson's little book is intended to call the attention of those interested in Kentucky to the urgent necessity of conserving the natural-gas reserves of the state, and to indicate the necessary steps to prevent waste. Incidentally, the book provides a good summary of the gas resources and industries of Kentucky. It should prove valuable both to producers and consumers of gas, both by calling attention to the consequences of waste and by its specific recommendations for conservation.

Dictionary of Applied Physics. Edited by Sir. Richard Glazebrook. Vol. 2. Electricity. Macmillan and Co., Ltd., London, 1922. Cloth, 6×9 in., 1104 pp., illus., $15.

The second volume of this important reference work contains many articles of importance to electrical engineers and physicists. Some of the longer articles are: Photoelectricity, by H. Stanley Allen; Technical Applications of Electrolysis, by A. J. Allmand; Arc Lamps, by R. E. Angold; Positive Rays, by F. W. Aston; Insulated Electric Cables, by C. J. Beaver; Switchgear, by R. A. R. Bolton; Capacity and Inductance, by Albert Campbell; Batteries, by W. R. Cooper; Electrons, by J. A. Crowther; Magnetic and Radio-Frequency Measurements, by D. W. Dye; Molecular Theories of Magnetism, by Kotaro Honda; Telephony, by F. B. Jewett; Magnet Design, by R. L. Jones; Stray-Current Electrolysis, by Burton McCollum; Thermionics, by O. W. Richardson and W. Wilson. Numerous bibliographies and a full index are provided.

Die-Casting. First edition. Industrial Press, New York, 1921. (Machinery's Dollar Books.) Paper 6×9 in., 108 pp., illus., diagrams, $1.

Describes briefly the development of die-casting machines, their commerical applications and the alloys used for die-casting. Based upon contributions to *Machinery*, and intended for those engaged in die casting.

Die Warme-Ein Gas. By Lothar Fischer. H. A. Ludwig Degener, Leipzig, 1922. Paper, 6×9 in., 61 pp., 38 marks.

This pamphlet is an attack on current opinion concerning the nature of heat. Heat is, according to this author, a gas. This gas he conceives as having an atomic weight far below that of hydrogen, and molecules of such minuteness that they diffuse easily through all substances. His monograph presents reasons for this opinion.

Engines and Boilers. By Thomas T. Eyrie. The Macmillan Co., New York, 1922. Cloth, 6×9 in., 234 pp., diagrams, $3.50.

An elementary course in heat engines for students of engineering, based on the author's experience in teaching engines and boilers and allied subjects at Purdue University.

Factory Storeskeeping. By Henry H. Farquhar. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 182 pp., illus., $2.50.

The materials considered in this book are the stores of raw materials and factory supplies, and worked materials or work in process and partly or completely finished parts. The book deals with the replenishment, storage and disbursement of these two classes of materials, but excludes the administration of work in process. The book outlines the principles and methods by which this problem may be solved and a system may be developed to suit local conditions, but does not outline a system for any specific type of factory.

Graduating, Engraving and Etching. First edition. Industrial Press, New York, 1921. (Machinery's blue books.) Paper, 6×9 in., 60 pp., illus., diagrams, $0.50.

The methods presented in this pamphlet are those commonly used by manufacturers of tools and instruments to graduate straight and circular scales and to engrave or etch name plates, etc. The dividing engines and engraving machines available are described and their use explained.

Graphic Charts in Business. By Allen C. Haskell. First edition. Codex Book Co., New York, 1922. Cloth, 6×9 in., 250 pp., charts, $4.

A companion volume to the author's earlier book, How to Make and Use Graphic Charts. The present work is confined to the charts most used for business purposes, line, bar, circular percentage, organization, trilinear and probability charts. Methods of making these are explained, their adaptability for various purposes is set forth and their application in various departments of business organizations illustrated. The ratio chart is explained fully. A bibliography is included.

The book is intended to help the man of business see when and how graphic charts can serve his purposes in controlling business operations.

Hydraulic Diagrams for the Discharge of Conduits and Canals. By Theodore Horton and C. H. Swan. Third edition. McGraw-Hill Book Co., Inc., New York, 1922. Paper, 6×9 in., 53 pp., diagrams, $1.

This set of diagrams is intended for use in the study of those sections of conduits and canals which are commonly used in sewerage, water supply, water power and drainage. The set includes conduits of ten different types of cross-section and canals of rectangular and trapezoidal cross-section. In this edition one diagram previously used has been replaced by three new diagrams of more useful types, and the text has been revised and extended.

Hydraulics. By Horace W. King and C. O. Wisler. John Wiley & Sons, New York, 1922. Cloth, 6×9 in., 237 pp., diagrams, $2.75.

This book deals with the fundamental principles of hydraulics and their application in engineering practice. Though many formulas applicable to different types of problems are given, it has been the aim to bring out clearly and logically the underlying principles that form the basis of such formulas rather than to emphasize the importance of the formulas themselves. The book is intended as a text for beginners and a reference book for engineers interested in the fundamental principles.

Liquid Fuel and Its Apparatus. By Wm. H. Booth. Second edition. E. P. Dutton and Co., New York, 1922. Cloth, 6×9 in., 308 pp., illus., diagrams, $4.

The object of this book is to present in a handy form the more practical points of the author's larger book, Fuel and Its Combustion. The present book is fairly closely confined to the use of liquid fuel under boilers and in internal-combustion engines. It discusses the principles of liquid fuel and the properties of fuel oils, gives examples of practice in using oil fuel for stationary boilers, locomotives and oil engines, and discusses burners and the storage, distribution and atomizing of oil.

Machine-Tool Operation. By Henry D. Burghardt. Part 2. Drilling machine, shaper and planer, milling and grinding machines. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 5×8 in., 438 pp., illus., diagrams, $2.75.

A textbook for trade schools and apprentices. The present volume, which follows one on lathe, bench and forge work, treats of drilling, shaping, planing, milling and grinding machines. Emphasis is laid on the fundamental principles of their construction and operation. These are discussed thoroughly as a foundation for rapid production.

Mastering Power Production. By Walter N. Polakov. Engineering Magazine Co., New York, 1921. Cloth, 6×9 in., 455 pp., plates, diagrams, $5.

Contents: The descent of the principle of production for use; power industry as an economic factor; location of plants; equipment of plants; mastering materials; mastering maintenance; mastering labor problems; mastering processes; mastering records; analysis of expenses; power as a commodity.

The subject of this volume is the technology of a method of mastering power production so that the best use of our resources will be made under present social, economic and political conditions. Mr. Polakov avoids discussion of the technical subjects already available in books on power engineering, and confines himself to the broader economic, psychological and engineering features. Special attention is given to management problems.

Modern Workshop Practice. By Ernest Pull. Sixth edition. D. Van Nostrand Co., New York, 1922. Cloth, 6×8 in., 671 pp., plates, illus., diagrams, tables, $5.

A textbook for students and machinists' apprentices. Deals with the common bench and machine tools, gages, lathes, lathe tools and fixtures, milling machines, planers, boring and slotting machines, and grinding machines. Describes methods of bench work, heat treatment, soldering and brazing, twining, screw cutting, gear cutting, planing, shaping, drilling and forging.

New Building Estimators' Handbook. By William Arthur. 1922 edition. U. P. C. Book Co., New York, 1922. Fabrikoid, 5×7 in., 1002 pp., illus., tables, $6.

This well-known handbook has been revised, and reset in a smaller, though legible type, so that its size has not been increased. It is intended to assist architects, builders, contractors and engineers in estimating the cost of new construction and repairs in all lines of building work, excavating and municipal work.

L'Union D'Electricité et la Centrale de Gennevilliers. By Ernest Mercier. La Revue Industrielle, Paris, 1922. Paper, 9×12 in., 48 pp., illus., plates.

The Union Francaise d'Electricité, formed in 1919, is a combination of the principal central stations serving Paris and its environs, organized to unify the system of distribution in existence, to eliminate competition between its organizers and to provide for the future in a rational way. This monograph describes the distributing system adopted and the generating stations acquired. The principal portion of the book is devoted to the new power plant under construction at Gennevilliers, planned for a present output of 200,000 kw., with future enlargement to 320,000 kw. This station is described in detail. Many plans and illustrations are given.

Production Milling. By Edward K. Hammond. First edition. Industrial Press, New York; Machinery Publishing Co., Ltd., London, 1921. Cloth, 6×9 in., 278 pp., illus., $3.

The purpose of this book is to explain the application of some of the more efficient methods of operating milling machines in the production of duplicate parts in quantities. The methods discussed have been collected from many sources and have all been successfully used under shop conditions. A knowledge of milling machines is assumed.

Well-Boring for Water, Brine and Oil. By C. Isler. Third edition. Spon & Chamberlain, New York, 1921. Cloth, 6×9 in., 259 pp., illus., diagrams, $4.80.

Describes various methods of boring and drilling in search of water, brine, oil or minerals, including driven and bored tube wells; the Kind-Chaudron, Dru, and Mather and Platt deep-boring systems; the American rope-boring system, and diamond drilling. Methods of raising water are dealt with. This edition is not only revised but also includes the methods which have been developed during recent years.

World Metric Standardization. Compiled by Aubrey Drury. World Metric Standardization Council, San Francisco, 1922. Cloth, 6×9 in., 524 pp., portraits, $5.

A comprehensive survey of the arguments advanced in favor of the adoption of the metric system in commerce. The testimony of proponents of the system has been collected from a wide range of sources and summarized in convenient form for consultation. A bibliography of over fifty pages is included.

PRECISION, STANDARDIZATION AND PRODUCTION

(Continued from page 730)

in hand. Before any product can be manufactured on an interchangeable basis, standards must be originated for all the interchangeable parts and surfaces. At first such standards were peculiar to each individual plant, but later many of them became common to all plants. As examples of such standards we have the conventional screw threads, bolts, nuts, etc.

The fear is sometimes expressed that standardization will tend to monotony. This comes from an imperfect knowledge of the nature and purpose of standardization. Again, many machine designers seem to fear that the extensive adoption and use of standards will limit their initiative and curtail their originality. Yet no one ever hears architects complaining that the adoption of standard sizes and forms for bricks, structural-steel members and joints, pipes, plumbing fixtures, electrical fixtures, etc., has limited their originality in designing new buildings. As a matter of fact, the adoption of these standards has relieved them of a large amount of drudgery on all minor details and left their minds clear for the important creative work. It is not so much the details themselves, but rather the effective arrangement and use of these details that is important.

At the present time the subject of standardization is receiving world-wide attention. It is becoming more and more apparent that standardization is one of the most effective means of promoting efficient production. Until quite recently, however, the development of standards has been a desultory process. Various engineering societies, trade associations, etc., have from time to time promulgated standards for the use of their own members. As no definite channels for coöperation existed, many matters which were equally important to several of the different associations were either left untouched, or handed in a limited way. To provide a definite means of coöperation, the American Engineering Standards Committee was formed. The nature of this committee and its method of operation is clearly stated in its report of its activities for 1921, as follows:

> The American Engineering Standards Committee essays to serve as a national clearing house for engineering and industrial standardization, to act as the official channel of coöperation in international standardization, and to provide an information service on engineering and industrial standardization matters. The ultimate responsibility for and control of the work rests with the organizations whose representatives constitute the American Engineering Standards Committee. At present these include five departments of the Federal Government, nine national engineering societies, and fourteen national industrial associations.
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> Each industry, or branch of industry, is wholly autonomous in its standardization work, the function of the Main Committee being merely to assure that each body or group concerned in a standard shall have opportunity to participate in its formulation, which is in the hands of a working committee, technically called a "sectional committee," made up of representatives designated by the various bodies interested.
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> In the work the sectional committee is the form in which agreements are worked out between the various organizations which speak for those branches of industry concerned in the particular standard for the formulation of which the sectional committee is responsible. Hence the sectional committee is necessarily made up primarily of accredited representatives of such organizations. A sectional committee also usually contains one or more outstanding specialists, not representing any particular organization. One of the most important duties of the Main Committee is the approval of the personnel and composition of each sectional committee, as being authoritative and adequately representative of the various interests concerned in the standard or group of standards, for the formulation of which the sectional committee is responsible.

The American Engineering Standards Committee has already started an extensive program. Its various sectional committees require much assistance from industry. Part of this is information in regard to current practice on different manufacturing and constructional subjects. So far this information has been hard to get. Several times, definite questionnaires have been sent out to several hundred factories; the number of replies seldom amounts to fifty. The only possible reason for this lack of response must be that the great importance of the subject of standardization is not fully realized.

The formulation of a standard is merely the first step. These standards must be put in extensive use before their full benefits become apparent. Engineers, designers, and draftsmen should keep themselves fully acquainted with the progress of the work of standardization and employ such standards wherever possible.

One word of caution, however, should be said at the outset. A standard does not necessarily meet every condition. The most it can do is to meet the majority of conditions. Exceptional cases will always require special consideration.

The mere publishing of a standard does not establish it. It can only become established by its common use. In order to remain in common use it must meet the majority of usual conditions as well as, or better than, any other construction would meet them. Thus a standard will become established or will be rejected entirely upon its intrinsic merits. The wide trial of proposed standards, however, will do much to show up any inherent defects in them, and thus enable them to be corrected. A wider response of manufacturers to requests for information from the various sectional committees will do much to prevent defective standards from being promulgated.

The subject of standardization is not limited to standard parts alone. It includes both assembled units and various types of machined surfaces—such as shaft and bearing diameters, keyways and key seats, etc. The extensive use of such standards leads to larger production of similar parts with resulting economy, and the larger production and stocking of standard tools for producing standardized surfaces.

The production of parts in larger quantities enables much more time and thought to be given to the methods for producing them. This in turn enables the part to be made with greater precision. Thus we have practically a complete circle. The increased accuracy of manufacturing equipment has made interchangeable manufacturing possible, and this again has made extensive standardization both desirable and possible. The extensive use of standards makes it economical to utilize the accuracy of the manufacturing equipment to the fullest extent.

The advantage of precision and standardization as regards production might be summed up as follows: It is cheaper to make a thing once and make it right than it is to make it wrong several times.

STANDARDIZATION OF SMALL TOOLS

(*Continued from page 723*)

This does not include the approximately 140 sizes of millimeter drills under $^1/_2$ in. diameter, nor the various odd styles of straight-shank drills such as tell-tale drills, dowel bits, etc. We are here dealing only with the kinds of drills in general use.

The establishment of sizes, particularly in Tables 1 and 2 appears to have been entirely empiric, as there are many duplications or near duplications with the fractional size drills, Tables 3 and 4. One is unable to find any uniform variation in diameter between consecutive sizes.

Table 5, which appears on page 723, is an attempt to establish uniformity of variation in diameter, and to eliminate sizes which are thought unnecessary. This will mean a reduction from 166 to 73 sizes.

It will be noted that the old symbols have been retained, but that the amount of variation in consecutive sizes has been arranged roughly in a geometrical progression. Thus we have:

From No. 80 to No. 78, diameter increases approximately	0.001 in.
From No. 77 to No. 57, diameter increases approximately	0.002 in.
From $^3/_{64}$ in. to $^1/_8$ in. diameter increases approximately	0.004 in.
From No. 29 to $^1/_4$ in., diameter increases approximately	0.008 in.
From $^{17}/_{64}$ in. to $^1/_2$ in., diameter increases approximately	0.016 in.

Reamers and milling cutters can be made subject to similar methods of standardization and with equally profitable results. No specific proposals are made, because it is realized that such standards must be created through suggestions from a wide field, and through careful consideration and discussion of the suggestions offered.

Tolerances and Nomenclature

The British Engineering Standards Association in 1920 published their Bulletin No. 122, entitled British Standards for Milling Cutters and Reamers. From the introduction to this publication the following is quoted:

> The standards herein contained have been arrived at as a result of conferences, research, and direct coöperation between the small-tool makers machine-tool makers, and users of this country, at whose instance the work was undertaken. . . . . .

An examination of the work done by the British engineers reflects their desire for uniformity in both design, tolerance, and nomenclature. Much of the material could probably be bodily adopted for use in this country, while some of it would necessarily have to be changed to suit our own conditions.

We all recognize the desirability of having definite limits established. It seems that as far as reamers are concerned there would be an excellent field for coördination with the existing standards of tolerances on shafts and holes.

Uniformity of nomenclature is particularly desirable for the sake of avoiding confusion and loss of time. We have frequently had cases where a customer will order some sort of tool we never heard of before. When we of necessity ask for further particulars, it is found that a standard tool is wanted, but that a local term is used for designating the same.

On the whole it is believed that the engineering societies in taking up this question of standardization of small tools will perform a service to the manufacturers of tools; but more particularly to the users.

In the end it is of course the consumer who pays the bill, and if through standardization this bill can be reduced, we shall have made a step forward in the march toward the goal of economical manufacturing.

THE ENGINEERING INDEX

(Registered United States, Great Britain and Canada.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ABRASIVE WHEELS

Breakage, Causes of. Grinding Wheel Breakage and Its Causes, Harold E. Jenks. Am. Mach., vol. 57, nos. 3 and 4, July 20 and 27, 1922, pp. 98–100 and 144–146, 6 figs. What produces stresses resulting in wheel breakage; effect of overspeeding. Details of correctly mounted wheel; necessity for balance; why wheels are weakened by balancing weights.

Grinding Tests. Factors Affecting Wheel Action H. W. Wagner. Abrasive Industry, vol. 3, no. 8, Aug. 1922, pp. 244–246, 2 figs. Account of tests conducted to determine grinding performance of wheels with various materials.

AERODYNAMICS

Curvilinear Motion. Notes on Aerodynamic Forces —II, Max M. Munk. Nat. Advisory Committee for Aeronautics Tech. Notes, no. 105, July 1922, 10 pp. Laws of curvilinear motion are established and transverse forces on elongated airship hulls moving along a curved path are investigated.

AERONAUTICAL INSTRUMENTS

Direction Instruments. Direction Instruments. Nat. Advisory Committee for Aeronautics. Aeronautic Instruments, section 4, report no. 128, 1922. 67 pp., 71 figs. Part I: Inclinometers and banking indicators. Part II: Testing and use of magnetic compasses for airplanes. Part III: Aircraft compasses. Part IV: Turn indicators.

Types. Instruments for Use on Aircraft. Engineering, vol. 114, no. 2954, Aug. 11, 1922, pp. 174–175, 9 figs. Describes altimeter dial, and aneroid barometer provided with scale which may be adjusted to suit any variations in pressure and temperature; air-speed recorder for speeds up to 80 m.p.h.; and an instrument for exploring radiator temperatures.

AERONAUTICS

Standardization. Aeronautical Standardization. Aviation, vol. 12, nos. 20 and 21, May 15 and 22, 1922, pp. 564–566 and 596–598, 2 figs. Standardization of materials, parts and tools desirable for mass production in emergencies suggested by two engineers experienced in factory as well as theoretical knowledge.

AIR COMPRESSORS

Rotary. New Rotary Air Compressor, E. Loewenstein. Mech. Eng., vol. 44, no. 9, Sept. 1922, p. 598, 2 figs. Describes new type with springless abutment blades. Results of tests undertaken at Goettingen Inst., Germany. Translated from Deutsche Optische Wochenschrift, vol. 8, no. 22, May 28, 1922, pp. 413–414.

Planche Rotary Compressor, Lucien Fournier. Mech. Eng., vol. 44, no. 6, June 1922, pp. 385–386, 8 figs. Describes rotary compressor, designed by French engineer, with disk piston moving in a conchoid. Translated from Génie Civil, vol. 80, no. 12, Mar. 25, 1922, pp. 275–277.

AIR PUMPS

Condensation. Investigations of Condensation Air Pumps (Untersuchungen an Kondensations-Luftpumpen), K. Hoefer. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 253, 1922, 92 pp., 48 figs. Investigations to determine relative efficiency of piston, steam-jet and water-jet air pumps with regard to economy, safety in operation, weight and space requirement. Results demonstrate advantages of steam-jet air pumps.

Radojet Dry-Air. The "Radojet" Air-Pump. Mech. World, vol. 72, no. 1860, Aug. 25, 1922, pp. 130–131, 4 figs. Describes dry-air pump which can be used in place of any other type of air pump. It is an ejector combination comprising tubular ejector in first stage and radial-flow ejector in second stage.

AIRCRAFT

Employment and Tactics. Employment and Tactics of Aircraft in Naval Warfare, John P. Jackson. U. S. Naval Inst. Proc., vol. 48, no. 8, Aug. 1922, pp. 1263–1297. Place of aircraft in military system; capabilities of aircraft; types; and methods of employment, such as: scouting, reconnaissance, and patrol; fire control, observation, and spotting; protection of fleet; attack on enemy surface and subsurface craft; transportation; etc.

AIRPLANE CONSTRUCTION MATERIALS

Rubber. Rubber Materials in Airplane Construction, C. J. Cleary. India Rubber World, vol. 66, no. 6, Sept. 1, 1922, pp. 801–802, 3 figs. Deals with clincher and straight-side tires, inner tubes, wheels and rims.

AIRPLANE ENGINES

Aeromarine U8D. Aeromarine Engine Passes 300 hr. Navy Test. Aviation, vol. 13, no. 6, Aug. 7, 1922, pp. 153–155, 3 figs. Characteristics of model U8D engine: no. of cylinders, 8; rated power 200 hp.; bore, 4.25 in.; stroke, 6.50 in.; displacement 737 cu. in.; dry weight of engine, 577 lb.

Fuel-Consumption Test. Fuel Consumption Test of DH-4B with Liberty "12" Engine. Air Service Information Circular, vol. 4, no. 346, May 15, 1922, 5 pp., 4 figs. Test to determine fuel consumption of engine at various speeds and altitude, and value of Schroeder econometer as means of measuring fuel consumption.

Performance. Comparative Performance Test of X.B.I.-A. Equipped with High Compression Wright Model "H" and Packard 1237 Engines. Air Service Information Circular, vol. 4, no. 327, Mar. 15, 1922, 8 pp., 5 figs. Description of airplane and engines and summary of results.

Valve Lift. Variation in Volumetric Efficiency of an Engine with Valve Lift, T. E. Tillinghast. Air Service Information Circular, vol. 4, no. 356, June 15, 1922, 11 pp., 7 figs. Experiments to determine (a) effect of changes in valve lift on volumetric efficiency, (b) effect of changes in compression ratio on volumetric efficiency, and (c) effect of changes in valve lift on engine performance.

AIRPLANE PROPELLERS

Design. Notes on Propeller Design, Max M. Munk. Aerial Age, vol. 15, nos. 8, 10, 12 and 13, May 1, 15, 29 and June 5, 1922, pp. 178–179, 225–226, 274–275 and 298–299, 1 fig. May 1: Energy losses of propeller. May 15: Distribution of thrust over propeller blade. May 29: Aerodynamical equations of propeller blade elements. June 5: Summary.

Stresses. Stresses in Airscrews due to Varying Engine Torque, John Case. Aeronautical Jl., vol. 26, no. 140, Aug. 1922, pp. 321–324. General analysis; values of constants; approximate calculations; bending moment due to acceleration; example.

AIRPLANES

Altitude Adjustments, Automatic. The Use of Multiplied Pressures for Automatic Altitude Adjustments, Stanwood W. Sparrow. Nat. Advisory Committee for Aeronautics Technical Notes, no. 108, Aug. 1922, 8 pp., 2 figs. Describes method of automatic compensation which deserves consideration in design of devices for making adjustments automatically.

Commercial. A Czecho-Slovak Commercial Aeroplane. Aeroplane, vol. 23, no. 6, Aug. 9, 1922, p. 106, 2 figs. Describes Ae.10, 5-seater cabin biplane for service on civil transport lines between Prague and Austria and Germany; 260 hp. Maybach engine.

Control Indicator. The Reid Aeroplane Control Indicator. Engineering, vol. 114, no. 2955, Aug. 18, 1922, pp. 216–218, 18 figs. Describes instrument comprising an air speed indicator, clinometer and turn indicator, all of which can be observed at a glance.

Design, Economical. Aerodynamical Efficiency and the Reduction of Air Transport Costs, Breguet. Aeronautical Jl., vol. 26, no. 140, Aug. 1922, pp. 307–313 and (discussion) 313–318. How to design airplanes which should reduce present rates of aerial freight by more than one-half.

Fuselage. Report of Static Test of XB-1-A Fuselage. Air Service Information Circular, vol. 4, no. 338, May 1, 1922, 9 pp., 9 figs. Test to determine strength of fuselage which had seen over 83 hours' service in air and been subjected to weather conditions for 1 year 4 months and 4 days.

Gliders. Description of the Hannover Glider. Aviation, vol. 13, no. 6, Aug. 7, 1922, pp. 156–157, 2 figs. Details of glider which made 4 1/3 mi. cross-country flight in 15 min. 40 sec. on second Rhön meeting.

Landing-Gear Shock Absorbers. Designing Landing Gear Shock Absorbers, Orrin E. Ross. Aviation, vol. 13, no. 8, Aug. 21, 1922, pp. 215–218, 8 figs. Practical method for determining size of cord, number of loops, tension, etc., for given service.

Navy Vought. Performance Test of Navy Vought Type XV Equipped with Wright Model E-2 Engine. Air Service Information Circular, vol. 4, no. 352, June 1, 1922, 6 pp., 6 figs. Summary of results; pilot's observations; distribution of weights; description of airplane and power plant.

Pressure Distribution. The Pressure Distribution over the Horizontal Tail Surfaces of an Airplane, III, F. H. Norton and W. G. Brown. Nat. Advisory Committee for Aeronautics, report no. 148, 1922, 26 pp., 33 figs. Deals with distribution of pressure during accelerated flight of full-sized airplane, for purpose of determining magnitude of tail and fuselage stresses in stunting.

Soaring. The M. I. T. Soaring Machine, Frank M. Gentry. Aerial Age, vol. 15, no. 18, Sept. 1922, pp. 451–452, 4 figs. Soaring plane developed by Aeronautical Eng. Soc. of Mass. Inst. Technology is of cantilever construction, with 120 sq. ft. of supporting surface and weighs 73 lb.; wing has spread of 24 ft., chord of 4 ft. 9 in. and aspect ratio of 5.

Structural Safety. Structural Safety During Curved Flight, Adolph Rohrbach. Nat. Advisory Committee for Aeronautics Tech. Notes, no. 107, Aug. 1922, 18 pp., 9 figs. Includes appendix with graphic determination of airplane speeds during rectilinear and curved flight, and propeller efficiency according to experiments with models. Translated from German.

Wings. The Twisted Wing With Elliptic Plan Form, Max M. Munk. Nat. Advisory Committee for Aeronautics Technical Notes, no. 109, Aug. 1922, 7 pp. Method for computing aerodynamic induction of wings with elliptic plan form if arbitrarily twisted.

AIRSHIPS

German. German Airships (Das deutsche Lufts-

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

chiff), Werner v. Langsdorff. Schiffbau, vol. 23, nos. 39, 43 and 44, June 28, July 26 and Aug. 2, 1922, pp. 1127–1132, 1185–1189 and 1211–1217, 11 figs. June 28: The Schütte-Lanz rigid airship. July 26 and Aug. 2: The Zeppelin airship.

Rigid. The U. S. Navy Airship ZR1. Aviation, vol. 13, no. 9, Aug. 28, 1922, pp. 254–256, 3 figs. Detailed description of America's first rigid airship now under construction; length overall, 680 ft.; height, 93 ft.; diameter 78.7 ft.; 1800 hp.; speed, 60 m.p.h.; gas volume, 2,115,174 cu. ft.

Semi-Rigid. The 18-Ton Parseval Semi-Rigid Airship "PL27." Flight, vol. 14, no. 25, June 22, 1922, pp. 354–357, 10 figs. Description of airship built in 1916 of type somewhat similar to "Roma."

ALCOHOL

Internal-Combustion Engines. Alcohol for Internal Combustion Engines. Engineer, vol. 133, no. 3463, May 12, 1922, p. 534. Account of experiments carried out with 95 volumes per cent alcohol by Empire Motor Fuels Committee.

ALLOY STEELS

Decomposition of Martensite. The Decomposition of Martensite into Troostite in Alloy Steel, Howard Scott. Blast Furnace & Steel Plant, vol. 10, no. 8, Aug. 1922, pp. 421–424, 3 figs. Effect of alloying elements on decomposition of martensite to troostite was determined by means of heating curves. Published by permission of Director of Bur. of Standards.

ALLOYS

Aluminum. See ALUMINUM ALLOYS; DURALUMIN.

Iron-Carbon. See IRON ALLOYS.

Nickel. See NICKEL ALLOYS; MONEL METAL.

ALUMINUM

Castings. Molds for Aluminum Castings. Am. Mach., vol. 56, no 24, June 15, 1922, pp. 896–898. Brass foundry practice modified for light, brittle aluminum; advantages of green sand cores; die castings stronger; how to test aluminum castings.

ALUMINUM ALLOYS

Castings. Notes on Aluminum Alloys for Casting. Chem. & Met. Eng., vol. 27, no. 10, Sept. 6, 1922, pp. 501–503. Useful foundry alloys contain relatively low percentages of copper, zinc or both; tabulation of physical properties of aluminum alloys used in America and other common metals and alloys.

Copper-Silicon-Aluminum. Physical Properties of Some Copper-Silicon-Aluminum Alloys When Sand Cast, E. H. Dix and A. J. Lyon. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 17 pp., 15 figs. Results of investigation conducted by Engineering Division of Air Service, covering alloys of 3, 6 and 9 per cent silicon with 0, 2, 4 and 6 per cent copper, and with 2 per cent copper and 1 per cent manganese are summarized.

Molding. Molding Practice for Aluminum Alloys. Chem. & Met. Eng., vol. 27, no. 11, Sept. 13, 1922, pp. 555–557. Notes on what is considered best practice. From sales dept. condensed data prepared by Tech. Dept., Aluminum Co. of America.

AUTOMOBILE ENGINES

Camshafts, Machining. The Machining of Camshafts, Fred H. Colvin. Am. Mach., vol. 57, no. 3, July 20, 1922, pp. 95–97, 9 figs. Use of multiple tools in turning camshafts. Master cams and cam-grinding methods.

Cooling Systems. Advantages of Evaporating Type of Cooling System, A. Ludlow Clayden. Automotive Industries, vol. 47, no. 11, Sept. 14, 1922, pp. 509–511, 2 figs. Describes steam-cooling system. Promises to be lighter, simpler and more efficient than conventional types; less likely to permit overheating and loss of water; no thermostats required; smaller radiator can be used.

Neglect of Water Flow Cuts Cooling Efficiency, A. Ludlow Clayden. Automotive Industries, vol. 47, no. 7, Aug. 17, 1922, pp. 306–309, 3 figs. Consideration of rate of water, flow at various points, and items such as pump design, arrangement of radiator, etc.

Heavy-Fuel. The Use of Crude Oil for Fuel in Automobile Engines (Verwendung von Rohöl als Betriebsstoff für Fahrzeugmotoren), Gustav Künzel. Motorwagen, vol. 25, no. 19–20, July 10–20, 1922, pp. 371–372, 2 figs. Describes carburetor which is recommended for use of heavy crude oils.

Ignition. See IGNITION.

Overhead Camshaft Efficiency. Do Overhead Camshafts Increase Efficiency in Engine Operation? P. M. Heldt. Automotive Industries, vol. 46, nos. 21 and 22, May 25 and June 1, 1922, pp. 1109–1144 and 1158–1161, 22 figs. Design leads to symmetrical engine of easy accessibility which need not be noisy. Used by four American makers and common in European practice. Read before Soc. Automotive Engrs.

Radiators. Air Flow in Relation to Water Cooling, A. Ludlow Clayden. Automotive Industries, vol. 47, no. 10, Sept. 7, 1922, pp. 462–466, 11 figs. Radiators compared; baffles increase efficiency; heat transfer; effects of water velocity.

Spark Plugs. See SPARK PLUGS.

Vauxhall. New Vauxhall Four Has Lanchester Harmonic Balancer, M. W. Bourdon. Automotive Industries, vol. 47, no. 10, Sept. 7, 1922, pp. 457–461, 7 figs. British passenger-car 23-60-hp. engine with overhead valves, designed to compete with 6-cylinder jobs in smooth-running qualities; duralumin tubing for push-rods.

AUTOMOBILE FUELS

See ALCOHOL; GASOLINE.

AUTOMOBILES

Camping Cars. Designing Camping Cars and Trailers, Harry W. Perry. Automotive Industries, vol. 47, no. 7, Aug. 17, 1922, pp. 324–327, 4 figs. Ideas about design of suitable trailer camping outfits.

German Chassis. Modern German Car Chassis Have Unique Details, Benno R. Dierfeld. Automotive Industries, vol. 47, no. 8, Aug. 24, 1922, pp. 359–362, 23 figs. Fan and water pump impeller on opposite ends of same shaft in some cases. Special facilities for ready adjustment of brakes on new Benz six. Mercedes has rigid central frame cross-member. Unconventional rear springs.

Grand Prix 1922. Some Mechanical Details of French Grand Prix Racing Cars, W. F. Bradley. Automotive Industries, vol. 47, no. 5, Aug. 3, 1922, pp. 210–212, 9 figs. High engine speed and failure of lubricating systems said to have caused some eliminations. Features of winning Fiat car.

Light Car. The 10 Hp. B. S. A. Car. Auto-Motor Jl., vol. 27, no. 32, Aug. 10, 1922, pp. 659–661, 8 figs. Example of air-cooled engined light car, capable of speed of 45 mi. per hr.

Marmon. The 34 Hp. Marmon Chassis. Automobile Engineer, vol. 12, no. 164, June 1922, pp. 162–170, 23 figs. Typical American design; rated horsepower, 33.75. Describes engine, induction system, lubrication, cooling system, electrical equipment, clutch, gearbox, brakes, suspension, etc.

Peerless. 1923 Peerless Carries Semi-Elliptic Springs, J. Edward Schipper. Automotive Industries, vol. 47, no 8, Aug 24, 1922, pp. 354–356, 5 figs. Platform type abandoned in new models; nearly every unit in car has been altered in some detail; frame design more rigid and easier to produce; wheels smaller.

Steam Cars. The Winslow Automotive Boiler, Charles B. Page. Soc. Automotive Engrs. Jl., vol. 11, no. 3, Sept. 1922, pp. 265–271 and (discussion) 271–272 and 274, 11 figs. Data and efficiency curves in support of claim that, per ton-mile or other work done, steam power and gas power are about at stand-off in weight of fuel consumed. History, construction and advantages of Winslow boiler.

Vauxhall. The 14 Hp. Vauxhall. Auto-Motor Jl., vol. 27, no. 35, Aug. 31, 1922, pp. 721–724, 11 figs. Built for economy in running costs; petrol consumption, 30 miles per gallon; maximum speed, 60 m.p.h.

B

BALANCING MACHINES

Dynamic. Dynamic Balancing Machine. Machy. (Lond.), vol. 20, no. 515, Aug. 10, 1922, pp. 574–577, 5 figs. Describes Lawaczeck & Heymann machine; attainment of balance at all speeds; first test of balance; plane of unbalance; sensitiveness of machine.

Martin. Balancing of High-Speed Machine Parts (Het uitbalanceeren van snel roteerende machinedeelen), W. Hamilton Martin. Ingenieur, vol. 37, no. 30, July 29, 1922, pp. 587–593, 7 figs. Static and dynamic balancing of rotating parts; Martin balancing machines.

BELTING

Dressings. German Formulae for Belt Dressings. Belting, vol. 21, no. 1, July 1922, pp. 17–18. Several formulas translated from German publication.

Leather. New Federal Specification for Leather Belting. Belting, vol. 21, no. 2, Aug. 1922, pp. 15–19, 1 fig. Adoption by Government intended to set first regular standards for users of products, manufacturers and distributors.

BEARINGS, BALL

Power Consumption. Tests on the Power Consumption of Ball and Journal Bearings for Driving Gear Shafts (Versuche über den Energiebedarf von Kugel- und Gleitlagern an Triebwerkswellen), M. Gohlke. Maschinenbau, vol. 1, no. 7, July 8, 1922, pp. 447–451, 7 figs. Results of tests show that ball bearings save about 50 per cent of work of friction of shaft, have longer life and lighter starting.

BLAST FURNACES

Reconstruction. Rebuilding Emporium Blast Furnace. Iron Trade Rev., vol. 71, no. 10, Sept. 7, 1922, pp. 651–653, 3 figs. Emporium Iron Co. discards hand-filling system and installs modern mechanical equipment. New construction includes storage bins, skip hoist, furnace top and pig-casting machine.

BLOWERS

Forced-Draft Furnaces. Tests on a Forced-Draft Furnace (Versuche an einer Unterwindfeuerung), E. Philipp. Feuerungstechnik, vol. 10, no. 20, July 15, 1922, pp. 224–226, 3 figs. Describes Schlotter blowers, built by Siemens-Schuckert Works, with air duct in axial direction; and installation in Wiesbaden electricity works equipped with these ventilators.

BOILER FEEDWATER

Softening. Softening Boiler-Feed Water with Zeolites. Power, vol. 56, no. 11, Sept. 12, 1922, pp. 412–414, 4 figs. How zeolites remove hardness; details of operation; data on typical installation; combination lime-zeolite treatment for water high in temporary hardness.

BOILER HOUSES

Sugar-Refining Co. The Boiler House of the American Sugar Refining Company at Baltimore, Maryland, E. B. Powell. Mech. Eng., vol. 44, no. 8, Aug. 1922, pp. 509–512, 4 figs. General features of plant; boilers, feedwater system; instruments; combustion equipment. (Abridgment.) See also Steam, vol. 30, no. 3, Sept. 1922, pp. 63–67, 4 figs.

BOILER OPERATION

Heat Losses. The Control of Boiler Operation, E. A Uehling. Mech. Eng., vol. 44, no. 7, July 1922, pp 438–443, 4 figs. Simplified formulas for use in calculating chimney, combustion and absorption losses. Proposed fuel unit for bituminous coal, etc. (Abridgment.)

BOILER PLANTS

Performance Tests. Fuel Economy from Old Plant Equipment, A. R. Mumford. U. S. Bur. of Mines Reports of Investigations, no. 2373, July 1922, 4 pp. Gives results of tests of two Babcock & Wilcox boilers fired by means of overfeed stokers and equipped with fuel economizer in uptake.

Rebuilding. Rebuilding a Large Boiler Plant Without Interrupting the Service, Alfred Iddles and J. Walter May. Power, vol. 56, no. 11, Sept. 12, 1922, pp. 402–408, 11 figs. Modern boiler plant, containing five water-tube boilers, each of 4900 sq. ft. of water-heating surface, was built on same location as old plant, without interfering with capacity of plant and without interrupting service supplied to large textile plant.

Stirling. The Stirling Boiler Plants of the Gennevilliers Central Station (Les chaufferies Stirling de la centrale de Gennevilliers), Jean Labadié. Révue Industrielle, vol. 52, nos. 8 and 9, June and July 1922, pp. 249–255 and 285–291, 14 figs. Notes on boilers, furnaces economizers, stoking arrangements, etc., and their operation.

BOILERS

High-Pressure. High-Pressure Boilers for the Waukegan Power Station. Power, vol. 56, no. 11, Sept. 12, 1922, pp. 417–418, 1 fig. Boilers, each having 14,086 sq. ft. of water-heating surface, of new design for 400 lb. pressure, which allows use of metal thicknesses in pressure parts no greater than in boilers designed for ordinary pressures.

Locomotive. See LOCOMOTIVE BOILERS.

Practice in 1922. Boiler Practice. Assn. Iron & Steel Elec. Engrs., vol. 4, no. 9, Sept. 1922, pp. 521–543, 3 figs. Symposium of following articles: The Trend of Boiler Development, J. B. Crane. Boiler Practices of 1922, R. E. Butler. The Modern Sectional Header Boiler, R. M. Rush. Heine Boiler Practice in 1922, E. R. Fish and Alfred Cotton.

Shovel-Stokered. Alder & Hentzen High-Capacity Boilers for Power Plants (Adler & Hentzen-Hochleistungsfeuerungen für den Kraftbetrieb), H. Pradel. Elektrotechnischer Anzeiger, vol. 39, nos. 129 and 130, Aug. 15 and 16, 1922, pp. 1009–1010 and 1015–1016, 7 figs. Describes double-ended vertical-tube boiler with shovel stokers.

Tests, Accuracy of. The Accuracy of Boiler Tests, Alfred Cotton. Mech. Eng., vol. 44, no. 7, July 1922, pp. 427–430 and (discussion) p. 437, 1 fig. Points out unavoidable inaccuracies involved in reports of boiler tests and absurdity of assigning values carried out to one-hundredth of one per cent to items which cannot possibly be measured so closely. Discusses factors entering into boiler-test computations. (Abridgment.)

BOILERS, WATER-TUBE

Improvements. Improved Water-tube Boilers. Engineer, vol. 134, no. 3477, Aug. 18, 1922, pp. 166–168, 6 figs. Details of and alterations in Nesdrum water-tube boilers built by Richardsons, Westgarth & Co., Middlesbrough.

Vertical. Calculation of a Vertical Water-Tube Boiler (Berechnung eines Steilrohrkessels), H. de Grahl. Glasers Annalen, vol. 9, no. 3, Aug. 1, 1922, pp. 43–47, 3 figs. Calculation of heat consumption for 1 kg. steam of 350 deg. cent. and 15 atmos.; weight and specific heat of combustion gases; temperature along heating surface.

BORING TOOLS

Pressure. Chart for Determining the Pressure Exerted by Boring Tools, J. B. Conway. Mech. World, vol. 72, no. 1860, Aug. 25, 1922, pp. 127–128, 1 fig. For purpose of determining end thrust and cutting pressure exerted by one- and two-lipped boring tools.

BRASS

Dezincification. The Dezincification of Brass, Ralph B. Abrams. Am. Electrochem. Soc. advance paper for meeting, Sept. 21–23, 1922, no. 1, 12 pp. Account and results of investigation.

High-Tenacity. The Development and Manufacture of High-Tenacity Brass and Bronze, O. Smalley. Foundry Trade Jl., vol. 26, nos. 309, 310, 311, 312 and 313, July 29, 27, Aug. 3, 10 and 17, 1922, pp. 47–49, 78–80, 99–101, 118–121 and 145–146, 14 figs. Treats synthetically development of complex high-strength brasses and considers principal problems of manufacture.

Properties. The Nature of Brass, A. E. White. Engrs.' Soc. of West. Pa. Proc., vol. 38, no. 1, Feb. 1922, pp. 7–25 and (discussion) 25–34, 24 figs. Properties of brasses and extent to which these properties are varied by cold working and by different degrees of annealing; fundamental laws under which grain growth in metals may occur.

Season Cracking. Season-Cracking, H. W. Brownsdon. British Non-Ferrous Metals Research Assn. Bul., no. 6, July 1922, pp. 11–18. Indicates chief factors giving rise to cracking of articles made of brass.

BRAZING

Dip. A Modern Method of Dip Brazing, C. A. Van Dusen. Am. Mach., vol. 57, no. 11, Sept. 13, 1922, pp. 408–410, 4 figs. Furnace and materials that produce best results; preparing and testing mixture for temperature; instructions for dipping parts.

BRONZES

Manganese. Manganese Bronze, F. A. Livermore. Foundry Trade Jl., vol. 26, no. 310, July 27, 1922, pp. 83–84. Practical suggestions as to manufacture and tests of physical properties.

C

CABLEWAYS

Suspended Cars. Suspended Elevators and Ferries (Schwebelift und Schwebefähre), Richard Petersen. Verkehrstechnik, vol. 39, no. 31, Aug. 4, 1922, pp. 401–405, 8 figs. Describes new German patents for conveyance of passengers and freight between two stations whose beeline connection is high over surface of earth. Suspended elevators connect station on cliff with one in valley, whereas suspended ferries connect two sides of a deep valley. Results of model tests.

CALCULATING MACHINES

Manufacture. Manufacturing Calculating Machine Side-Frames, Fred H. Colvin. Am. Mach., vol. 57, no. 7, Aug. 17, 1922, pp. 256–258, 8 figs. Methods and tools used by Monroe Calculating Machine Co. Gages and how they are used.

CAR WHEELS

Chilled-Iron. The Griffin Wheel (Das Griffinrad) Emil Rüker. Glasers Annalen, vol. 91, no. 3, Aug. 1, 1922, pp. 33–43. Statistics on fracture of tire and life of wheels. Investigation of speed limits, maintenance costs, influence of continuous braking of trains. Experiences in practice and workshop. Bibliography.

CARS

Dining. Steel Diners for the Atchison, Topeka & Santa Fe. Ry. Age, vol. 73, no. 11, Sept. 9, 1922, pp. 459–460, 4 figs. Cars are 86 ft. 6 in. long over end sills and weigh 171,000 lb.; tables seat 36 persons.

Self-Propelled. Self-Propelled Cars on Steam Railways. Can. Ry. & Mar. World, no. 294, Aug. 1922, pp. 417–419, 4 figs. Description of equipment on Can. Nat. Rys. This equipment is both of American and Canadian origin.

CARS, FREIGHT

Design. Some Factors to be Considered in Freight Car Design, H. W. Williams. Ry. Rev., vol. 71, no. 9, Aug. 26, 1922, pp. 269–271. Evolution of design leading toward standardization and reduction in weight.

Transformers, Transportation of. Trucks for the Railway Transportation of Large Transformers (Wagen für den Eisenbahntransport eines fertigen Grosstransformators), Erich Klein. Elektrotechnische Zeit., vol. 43, no. 28, July 22, 1922, pp. 939–941, 5 figs. New arrangement is described for transportation and loading of large transformers without use of special hoisting machines.

CARS, REFRIGERATOR

Design and Operation. Some Notes on Railway Refrigerator Cars, W. H. Winterrowd. Mech. Eng., vol. 44, no. 7, July 1922, pp. 419–426, 13 figs. Facts relating to principles of railway refrigerator-car operation and information about various types of cars and methods of design and construction. (Abridgment.)

Mechanical Refrigeration of. Mechanical Refrigeration of Railroad Cars, W. M. Baxter. Mech. Eng., vol. 44, no. 9, Sept. 1922, pp. 570–574, 8 figs. Technical, economic and operating aspects of various attempts to employ mechanical refrigeration in railroad refrigerator cars, with details of proposed dense-air system for that purpose. (Abridgment.)

Santa Fe Railway. New Designs of Refrigerator Cars for the Santa Fe. Ry. Age, vol. 73, no. 5, July 29, 1922, pp. 189–193, 10 figs. Include two similar types, one with movable, other with stationary bulkheads. See also Ry. Mech. Engr., vol. 96, no. 8, Aug. 1922, pp. 455–459, 10 figs.

CARS, TANK

Acid. Tank Cars for Transportation of Muriatic Acid, J. M. Rowland. Chem. Age, vol. 30, no. 7, July 1922, pp. 299–301, 3 figs. Description of construction of car and discussion of lining with particular reference to unvulcanized para rubber linings.

CASE-HARDENING

Localized. Problems in Localized Case Hardening, R. A. Millholland. Iron Age, vol. 110, no. 5, Aug. 3, 1922, pp. 265–266. Low-carbon machine steel used; after carburization and annealing, material to be removed machinable and not distorted in subsequent hardening.

Prevention. Methods for Locally Preventing Case Hardening, Jean Galibourg and Marcel Ballay. Iron Age, vol. 110, no. 3, July 20, 1922, pp. 136–137. Protective layers applied with brush and coating with copper compared by French authorities. Translated from Revue de Métallurgie, Apr. 1922.

CAST IRON

Chemical Composition. Cast Iron and Its Chemical Composition, O. Smalley. Engineering, vol. 114, no. 2957, Sept. 1, 1922, pp. 277–281, 22 figs. Notes on semi-steel; oxygen in cast iron; casting temperatures; solidity of cast iron; effect of composition on strength of cast-iron hot, etc. Paper read before British Foundrymen's Assn.

Electric-Furnace Production. Cast Iron as Produced in the Electric Furnace, and Some of Its Problems, George K. Elliott. Chem. & Met. Eng., vol. 27, no. 3, July 19, 1922, pp. 116–120. Basic electric furnace is useful to refine cupola-melted iron, reducing sulphur and gases to any extent desired, and producing easily machinable castings, very tough and strong, and with minimum of defectives from dirt or blowholes. Paper read before Am. Electrochem. Soc.

Ferrite-Graphite Eutectic. The Ferrite-Graphite Eutectic as a Frequent Phenomenon in Certain Kinds of Cast Iron (Das Ferrit-Graphit-Eutektikum als häufige Erscheinung in gewissen Gusseisensorten), Emil Schüz. Stahl u. Eisen, vol. 42, no. 35, Aug. 31, 1922, pp. 1345–1346, 4 figs. Details of structure; theory of origin; influence of composition.

Low Temperature, Influence of. Some Influences of Low Temperature on the Strength and Other Properties of Cast Iron, A. Campion. Foundry Trade Jl., vol. 26, no. 308, July 13, 1922, pp. 32–36, 2 figs. Results of tests made on irons of different qualities and compositions; on repeated heating and cooling, changes of weight were found.

Melting. Heat Factors Govern Melting, Y. A. Dyer. Foundry, vol. 50, no. 16, Aug. 15, 1922, pp. 661–662. Importance of thermophysics in melting, superheating, pouring and cooling iron illustrated by effects enumerated and study of results obtained from combustion of coke in cupola.

Nickel-Chromium, Effect of. Effect of Nickel-chromium on Cast Iron, Richard Moldenke. Am. Inst. Min. & Met. Engrs. Trans., no. 1187-S, Sept. 1922, 23 pp., 12 figs.; and (abstract) in Min. & Metallurgy, no. 189, Sept. 1922, pp. 54–55, 3 figs. Describes making of pig iron from Mayari iron ores of Cuba, and gives tables of results of tests, series of curves showing interrelation of elements involved, and summary of conclusions derived.

Specifications. Report of Committee A-3 on Cast Iron. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 14 pp., 2 figs. Proposed tentative specifications for chilled cast iron wheels, foundry pig iron and high-test gray-iron castings.

Steel Scrap in Cupola. Steel Scrap in Cupola Iron Mixtures, E. J. Lowry. Iron Age, vol. 110, no. 6, Aug. 10, 1922, pp. 337–338, 3 figs. Strength of product and percentages of scrap. Experiments and results. Effect on hardness.

CASTING

Centrifugal. Centrifugal Casting, Leon Cammen. Mech. Eng., vol. 44, no. 8, Aug. 1922, pp. 500–504, 4 figs. Résumé of development and discussion of design and operating problems of centrifugal-casting processes and their field of application. Manufacture of plates by this process. (Abridgment.)

CENTRAL STATIONS

Superpower. The Gennevilliers Plant and the Distribution of Electric Energy in the Paris District (L'Usine de Gennevilliers et la distribution de l'énergie électrique dans la région Parisienne), F. Loppé. Industrie Électrique, vol. 31, no. 722, July 25, 1922, pp. 265–276, 10 figs. Describes buildings, boiler house, 50,000-hp. turbo-alternators, 50,000-hp. turbines, etc.

The New Superpower Plant Near Paris Approaching Completion. Elec. World, vol. 80, no. 6, Aug. 5, 1922, pp. 264–270, 14 figs. Details of Gennevilliers power plant on Seine River, ultimately to be rated at 320,000 kw. See also article by R. H. Andrews in Power, vol. 56, nos. 5 and 7, Aug. 1 and 15, 1922, pp. 156–162, 5 figs. and 232–236, 6 figs.

CHEMICAL PLANTS

Design. The Design of Chemical Plants, A. E. Marshall. Chem. & Met. Eng., vol. 27, no. 9, Aug. 30, 1922, pp. 439–441. Handling of materials through plant and influence of plant design on cost of pre-process and process labor.

The Modern Chemical Plant, Frank D. Chase. Chem. & Met. Eng., vol. 27, no. 9, Aug. 30, 1922, pp. 432–434. Factors to be taken into account in designing plant, viz., location, layout, design, construction and equipment.

Production Efficiency. Increased Production Efficiency in the Industries. Chem. & Met. Eng., vol. 27, no. 9, Aug. 30, 1922, pp. 457–468. Outstanding deficiencies in production processes. Concise statements by leading representatives of chemical and related industries in answer to question, "What would contribute most to increased production efficiency in your industry?"

CHIMNEYS

Compound. The Nast System of Compound Chimneys (Die schalungslose Verbundbauweise "Nast"), Paul Frei. Beton u. Eisen, vol. 21, nos. 5 and 6, Mar. 18 and Apr. 5, 1922, pp. 78–81 and 90–91, 7 figs. Mar. 18: Construction of reinforced-concrete stacks; improvements introduced by patent of B. Nast. Apr. 5: Describes chimneys 62 to 117 m. high at Oppau works, all of which passed through explosion unharmed.

CHROMIUM STEEL

Corrosion, Resistance to. Resistance to Corrosion of Various Types of Chromium Steels, Henry S. Rowdon and Alexander I. Krynitsky. Chem. & Met. Eng., vol. 27, no. 4, July 26, 1922, pp. 171–173. Abstract of research carried out at Bur. of Standards. Corrosion in air differs from that in dilute hydrochloric acid.

Solidification, Speed of. The Influence of Speed of Solidification on Double-Carbide Steels (Ueber den Einfluss der Ertsarrungsgeschwindigkeit auf die Doppel-Karbidstähle) P. Oberhoffer. Stahl u. Eisen, vol. 42, no. 32, Aug. 10, 1922, pp. 1240–1242, 6 figs. Results of tests carried out on a series of chrome steels.

COAL HANDLING

Haulage, Hoisting and Dumping. Cambria Steel Co. Drops Coal Down Well, Loads It at Bottom and Hauls It to Ovens, George A. Richardson. Coal Age, vol. 22, no. 9, Aug. 31, 1922, pp. 313–317, 7 figs. Coal is passed down 110-ft. shaft from upper bed to lower and is reloaded for 2-mile run to Rosedale ovens; electrically actuated gates load through measuring hopper.

Haulage, Hoisting and Dumping Practices At Rosedale Mine, George A. Richardson. Coal Age, vol. 22, no. 10, Sept. 7, 1922, pp. 351–357, 22 figs. Practices of Cambria Steel Co. Largest mine locomotives made haul 145 cars, each holding 1½ gross tons; hoisting shaft has coal well carrying coal to skip-loading level; shaft capacity 10,000 tons daily; steel guides; hilted sprags.

Pit Car Loaders. Mechanical Pit Car Loaders, Reginald Trautschold. Coal Industry, vol. 5, no. 6, June 1922, pp. 283–285, 4 figs. Mechanical loading device will operate to greatly reduce mining costs of given proper chance, but good management is essential to success; types of loaders and operating data.

Temperley Transporter. The Temperley Transporter for Coal Handling, H. Hubert. Commonwealth Engr., vol. 9, no. 11, June 1, 1922, pp. 391–395, 5 figs. Describes conditions which govern size of plant, and by actual examples, shows how existing requirements have been successfully met by Temperly transporters.

Turntables, Use of. Enlisting the Turntable in Mechanical Coal Loading, E. N. Zern. Coal Age, vol. 22, no. 8, Aug. 24, 1922, pp. 283–285, 2 figs. Turntable is located on room track opposite line of crosscuts which intersect five consecutive rooms and give a storage road for cars near loading machine.

COAL STORAGE

Cable Drag-Scraper Method. Coal Handling by Drag Scraper, C. W. Ross. Gas Age-Rec., vol. 50, no. 8, Aug. 19, 1922, pp. 230–232, 6 figs. Suggestions for storage so as to prevent spontaneous combustion, methods of storing; cable drag-scraper storing system.

Experiments. Experiments in Coal Preservation, M. Forrières. Gas Jl., vol. 159, no. 3092, Aug. 16, 1922, pp. 375–376. Results of very complete laboratory experiments carried out with view of determining behavior of similar coals, stored with free access to air circulation, with restricted air circulation, and under water.

COKE

Specific Gravity. Volumetric Determination of the Actual and Apparent Specific Gravity of Coke (Volumetrische Bestimmung des wirklichen und des scheinbaren spezifischen Gewichtes von Koks), A. Schmolke. Glückauf, vol. 58, no. 32, Aug. 12, 1922, pp. 977–980, 1 fig.; also Stahl u. Eisen, vol. 42, no. 32, Aug. 10, 1922, pp. 1237–1240, 1 fig. Describes simplified method of investigation.

COKE HANDLING

New System. A New System of Coke Handling, H. Blyth. Gas Engr., vol. 38, no. 556, Aug. 15, 1922, pp. 205–206, 2 figs. Method which effects considerable economy at very moderate capital expenditure.

COKE MANUFACTURE

By-Product. By-product Coking, F. W. Sperr, Jr. Jl. Indus. & Eng. Chem., vol. 14, no. 9, Sept. 1922, pp. 844–846. Property and process of coking; by-product formation; properties and utilization of coke; materials of plant construction.

COKE-OVEN GAS

Boilers for Burning. Coke-Oven Gas and Its Use in Boilers (Das Koksofengas und seine Verfeuerung in Dampfkesseln), A. Sauermann. Glückauf, vol. 58, no. 30, July 29, 1922, pp 922–926, 4 figs. Fundamentals for design of boilers and burners for use of coke-oven gas. Properties of gas during combustion.

COLD STORAGE

Research. The Low Temperature Research Station at Cambridge, L. F. Newman. British Cold Storage & Ice Assn., vol. 18, no. 2, 1921–1922, pp. 5–17 and (discussion) 18–28. Investigation of entire problem of cold-storage losses and description of new station.

COLUMNS

Reinforced-Concrete. Slenderness - Ratio and Strength of Concrete Columns, F. E. Giesecke. Eng. News-Rec., vol. 89, no. 7, Aug. 17, 1922, pp. 274–276, 7 figs. Effect of length found to be negligible; influence of water ratio and mixing; buckling controlled by eccentric loading.

COMBUSTION

Maximum Temperature Calculation. Rapid Calculation of Theoretical Maximum Temperatures, George Granger Brown. Chem. & Met. Eng., vol. 27, no. 10, Sept. 6, 1922, pp. 497–500, 3 figs. Four methods for computing temperature developed by a reaction: graphical, by trial, algebraic, and slide rule. From paper read before Am. Chem. Soc.

CONDENSERS, STEAM

Air Extractors. Tests on Delas Air Extractor. Iron & Coal Trades Rev., vol. 105, no. 2839, July 28, 1922, pp. 116–117, 5 figs. Inventor has stabilized extractor by method of introducing external cold-water circulation instead of atmospheric air into divergent.

Surface. Surface Condensing Plant. Engineer, vol. 134, no. 3473, July 21, 1922, pp. 70–72, 9 figs.

Describes new installation in Pinkston power station of Mirrlees Watson surface condenser, designed to work with 10,000-kw. 1500-rev. turbo-generator, and capable of maintaining vacuum of 27.8 in., with cooling water at 75 deg. fahr. when dealing with 185,000 lb. of steam per hr.

CORROSION

Metals and Alloys. Preliminary Notes on Corrosion, Wilder D. Bancroft. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 5 pp. Points out desirability of developing rapid method for studying corrosion.

COST ACCOUNTING

Factory. Cost Accounting and Factory Efficiency, George P. Comer. Chem. & Met. Eng., vol. 27, no. 9, Aug. 30, 1922, pp. 417–421. Control of production; basic schemes of distribution; essential elements of cost; departmental cost sheet; costs of idle equipment; cost and sales summary; uniform cost systems.

Rolling-Stock Production. Railway Carriage and Wagon Building Costs. Ry. Engr., vol. 43, no. 511, Aug. 1922, pp. 289–294, 17 figs. New system installed at works of Midland Ry., Derby, for ascertaining and checking rolling-stock production costs.

CRANES

Cableway. Cableway Cranes (Kabelkrane), Friedrich Riedig. Fördertechnik u. Frachtverkehr, vol. 15, no. 15, July 21, 1922, pp. 195–201, 15 figs. Use of cableway cranes for building of bridges, dams, harbors, canals, etc.; for loading of bulk goods; and for shipbuilding. Efficiency of such cranes and comparison with loading bridges.

Floating and Hammerhead. Large Cranes for Shipyards and Harbor Service, E. Krahnen. Mar. Eng., vol. 27, no. 9, Sept. 1922, pp. 583–585, 3 figs. Construction and operation of 250-ton hammerhead and floating cranes built in Germany for fitting out large ships.

Locomotive. A Crane Works at Rodley. Engineer, vol. 134, no. 3475, Aug. 4, 1922, pp. 122–123, 8 figs. Describes works of Thomas Smith & Sons, Ltd., for manufacture of locomotive cranes.

Workshop. The Louden-King Push-and-Pull Crane, George F. Zimmer. Eng. & Indus. Management, vol. 8, no. 3, Aug. 24, 1922, pp. 95–97, 7 figs. Overhead, hand-operated crane for loads up to 1000 lb.

CUPOLAS

Hot-Blast. Utilizing Heat of the Cupola to Warm the Blast. Can. Foundryman, vol. 13, no. 8, Aug. 1922, pp. 18–19, 3 figs. By having cast-iron jacket above melting zone, air is heated from waste heat of fuel, before passing into fire.

CUTTING TOOLS

Diamond. Diamond Tools as Cost Reducers. Machy. (N. Y.), vol. 29, no. 1, Sept. 1922, pp. 33–37, 7 figs. Gives brief description of preparation of diamonds for commercial use, indicates how they are set in holders, and furnishes information regarding their cost. Multiple-stone diamond dresser for emery wheels.

CYLINDERS

Metal-Faced Cores. Using Metal Faced Cores in Cylinders. Foundry, vol. 50, no. 16, Aug. 15, 1922, pp. 684–685, 4 figs. Patent claim of T. P. Greenhow is based on method of application and preparation employed to cover metal face of core to prevent metal from chilling. Method has been applied at plant of Buick Motor Co., Fliat, Mich.

Welded, Tests on. Tests on Welded Cylinders, E. A. Fessenden and L. J. Bradford. Mech. Eng., vol. 44, no. 9, Sept. 1922, pp. 581–586 and 592, 14 figs. Describes tests conducted in order to compare methods of constructing cylinders for handling anhydrous ammonia, and discusses results. Author concludes that vessels having forge-welded heads are least reliable and that burnt steel is often present in weld; principal defects in acetylene welds are coarse granular structure and porous spots and pinholes that develop with high pressures. Practical remedies are given. (Abridgment.)

D

DIE CASTING

Aluminum Bronze. Aluminum-Bronze Die Castings. Machy. (Lond.), vol. 20, no. 509, June 29, 1922, pp. 377–380, 6 figs. Die-cast and sand-cast pieces compared. Metal, dies, and methods used in process.

Operations and Equipment. Die Casting in a Small Shop. Eng. Production, vol. 5, no. 97, Aug. 10, 1922, pp. 128–132, 8 figs. Operations and equipment.

DIESEL ENGINES

Double-Acting Type. Design of Novel Diesel. Practical Engr., vol. 66, no. 1864, July 13, 1922, p. 26. Engine consists of two cylinders bolted together in middle and free to reciprocate relatively to covers.

Manufacture. The Manufacture of Diesel Engines. Engineer, vol. 133, no. 3465, May 26, 1922, pp. 588–590, 17 figs. Methods and equipment of Mirrlees, Bickerton & Day, Ltd., Hazel Grove.

Marine. A Double Acting Marine Diesel Engine. Mar. Eng., vol. 27, no. 9, Sept. 1922, pp. 567–569, 4 figs. Satisfactory tests on 250-hp. unit causes rapid construction of three-cylinder, two-cycle 2,000-b.hp. engine.

The 1600-Hp. 4-Stroke Diesel Engine of the Augsburg-Nurnberg Machine Factory (M. A. N.) (1600 PSe-Viertakt-Dieselmotor der Maschinenfabrik Augsburg-Nürnberg A. G., Werk Augsburg). Schiffbau, vol. 23, nos. 45 and 46–47, Aug. 9 and 16–23, 1922, pp. 1231–1236 and 1255–1258, 15 figs. Description of engine. 4-weeks duration test at the Augsburg Works. Operation with anthracite tar oil and viscous crude oil.

The Sulzer Two-Stroke Diesel Engine. Engineering, vol. 114, nos. 2954 and 2956, Aug. 11 and 25, 1922, pp. 169–173, 14 figs. partly on supp. plate; and 224–227, 7 figs. Most important feature of engine is said to be method of scavenging cylinders. Other important features and details. Results of tests.

Nordberg Small-Power. Diesel Engine for Small Plants. Power, vol. 56, no. 5, Aug. 1, 1922, pp. 163–165, 6 figs. Discusses motives prompting Nordberg Mfg. Co. to design Diesel engines of small powers and describes important details of design.

DRILLING MACHINES

Drill Heads, Multi-Spindle. Adjustable Multi-Spindle Drill Heads. Eng. Production, vol. 5, no. 93, July 13, 1922, pp. 28–29, 4 figs. Description of drill head in which spindles can be adjusted for height so that when setting up it is not necessary for drills to be of equal length.

DROP FORGING

Methods. Drop Forging. Eng. Production, vol. 5, no. 98, Aug. 17, 1922, pp. 157–163, 21 figs. Methods, equipment and products of Thomas Smith's Stamping Works, Ltd., Coventry, England.

DRY KILNS

Lumber Piling. The Value of Drykiln Efficiency Tests. Wood-Worker, vol. 41, no. 6, Aug. 1922, pp. 39–40, 4 figs. Results of series of tests made by Vancouver Lumber Co., Ltd., Vancouver, B. C., to determine most efficient methods of piling lumber in dry kilns.

DURALUMIN

Properties and Methods of Using. Properties and Methods of Using Duralumin. Automotive Industries, vol. 47, no. 8, Aug. 24, 1922, pp. 370–376, 10 figs. This aluminum alloy has about same ultimate strength as structural steel but weighs one-third as much; can be heat-treated, rolled, stamped, cast, forged, welded and readily machined; possesses characteristics which render it valuable to automotive industry.

E

ECONOMIZERS

Operation. Economisers and Economiser Operation, Frank H. Prouty. Power House, vol. 15, Aug. 5, 1922, pp. 25–26. Status in American practice. Progress in structural details. Modifications in soot-cleaning arrangements. Operating features.

EDUCATION, ENGINEERING

Petroleum Engineering. Petroleum Education, Edwin DeBarr and Fred W. Padgett. Chem. & Met. Eng., vol. 27, no. 3, July 19, 1922, pp. 125–127. Attempted outline of specialized courses for prospective graduates in petroleum engineering. Paper read before Am. Chem. Soc.

ELECTRIC DRIVE

Metal Works. Electrification of the International Nickel Company's Works for Monel Metal, F. C. Watson. Assn. Iron & Steel Elec. Engrs., vol. 4, no. 9, Sept. 1922, pp. 415–454, 12 figs. Details of electric power-supply equipment of Huntington Works in West Virginia.

ELECTRIC FURNACES

Acid. Notes on Acid Electric Furnace Practice, Charles W. Francis. Iron Age, vol. 110, no. 6, Aug. 10, 1922, pp. 345–346. Basic scrap and how to charge it; making a new bottom; when to tap and how to pour; alloy additions in furnace.

Basic. Notes on Basic Electric Furnace Operation, Charles W. Francis. Iron Age, vol. 110, no. 7, Aug. 17, 1922, pp. 421–422. Grade of lime necessary; reducing phosphorus and sulphur; high and low tap voltages.

Circulation of Molten Metal. The Circulation of Molten Metal by Means of Electrodynamic Forces, Oscar Brophy. Chem. & Met. Eng., vol. 27, no. 10, Sept. 6, 1922, p. 489, 1 fig. Discusses the three important electrodynamic forces that may be used to circulate molten metal, viz., pinch, effect, corner effect, and motor effect.

Foundries. Economy Features of Electric Foundry, Charles W. Francis. Iron Age, vol. 110, no. 5, Aug. 3, 1922, pp. 277–278. Locating furnace and supply bins; handling materials; caring for electrodes.

The Electric Furnace for the Foundry, Charles W. Francis. Iron Age, vol. 110, no. 4, July 27, 1922, pp. 201–202. Considerations in choosing proper unit for making steel castings. Place of acid and basic operations.

Induction. A New Induction Furnace, J. Murray Weed. Am. Electrochem. Soc. advance paper, no. 5, for meeting, Sept. 21–23, 1922, pp. 27–34, 3 figs. Describes induction furnace for melting non-ferrous metals, in which secondary consists of molten charge which is distinct from melting pot.

Induction Furnace for Melting Non-Ferrous Metals. Metal Industry (N. Y.), vol. 20, no. 8, Aug. 1922, pp. 312–313, 2 figs. New type developed by Gen. Elec. Co.

Processes and Equipment. The Electric Furnace, John B. C. Kershaw. Eng. Production, vol. 5, nos. 96, 97 and 98, Aug. 3, 10 and 17, 1922, pp. 103–106, 122–125 and 146–148, 23 figs. Modern processes and equipment.

Smelting Pig Iron. Electric Smelting of Pig Iron in Sweden. Engineer, vol. 134, no. 3471, July 7, 1922, pp. 5–6, 4 figs. Describes Swedish electric furnace which is a combination of blast-furnace shaft with an electric hearth.

Status. Status of Electric Furnaces, L. H. Knapp. Elec. World, vol. 80, no. 12, Sept. 16, 1922, pp. 605–609, 9 figs. Electric melting and refining fairly well established for high-grade steel; application of electric heat to non-ferrous metallurgy and heat treating still growing rapidly.

Steel. Costs of Electric Steel Melting, Charles Wellman Francis. Iron Age, vol. 110, no. 9, Aug. 31, 1922, pp. 525–526. Comparison of methods shows basic higher than acid; power charge, electrodes and labor chief controlling items.

Furnace Has Sealed Electrodes, G. Vitali. Iron Trade Rev., vol. 71, no. 9, Aug. 31, 1922, pp. 585–586, 2 figs. Units in electric steel plant of Fiat establishment in Italy embody radical changes in design of electrodes. Use 130-volt current for melting and 75-volt for refining operation. Translated from Stahl u. Eisen.

ELECTRIC LOCOMOTIVES

Design. Electric Locomotives, Vincent L. Raven. Electrician, vol. 89, no. 2304, July 14, 1922, pp. 36–38, 2 figs. Requirements for which any locomotive must be designed, the various designs which have been worked out to meet these requirements, and advantages and disadvantages of the various designs which have been completed. Paper read before Instn. Mech. Engrs. See also Ry. Engr., vol. 43, no. 510, July 1922, pp. 252–256, 2 figs.

High-Speed. High-Speed Electric Passenger Locomotive, North Eastern Railway, V. L. Raven. Ry. Gaz., vol. 37, no. 1, July 7, 1922, pp. 23–24, 2 figs. partly on p. 22. Describes 4–6–4 type designed by author; total capacity, 1800 hp.; three pairs of motors; tractive effort, 15,900 lb.; speed, 43 m.p.h.

Passenger, N. E. Ry. High Speed Electric Passenger Locomotive, North Eastern Railway. Ry. Engr., vol. 43, no. 511, Aug. 1922, pp. 296–297 and 313, 3 figs. Characteristics: Wheel arrangement, 4–6–4; electric system, d.c.; voltage, 1500; overall length, 53 ft. 6 in.; overall width, 8 ft. 10 in.; driving wheel diam., 6 ft. 8 in.; rigid wheelbase, 16 ft.; weight, 102 tons; horsepower, 1300; speed 51.5 m.p.h.

Vibration-Recording Apparatus. The Recording of Vibrations, Especially Torsional Fluctuations (Die Registrierung von Erschütterungen, insbesondere von Dreh-Schwankungen), Schweizerische Bauzeitung, vol. 80, no. 7, Aug. 12, 1922, p. 80, 3 figs. Details of the torsiograph, a recording apparatus, designed by J. Geiger, Augsburg, Germany. Results of tests by Brown, Boveri & Cie.

ELECTRIC RAILWAYS

Equipment N. Y., N. H. & H. New Single Phase Equipment for the New Haven, Walter H. Smith. Ry. Elec. Engr., vol. 13, no. 8, Aug. 1922, pp. 259–262, 8 figs. Dimensions and equipment of new motor cars, employing four 175-hp. Westinghouse-type 409-D single-phase, 25-cycle, series motors. Two master controllers installed in trail cars permit operation from any car in train.

Multiple-Unit Equipment. New Multiple-Unit Equipment for Long Island R. R., R. H. Freeland. Ry. Rev., vol. 71, no. 3, July 15, 1922, pp. 81–83, 3 figs. Improved Westinghouse control adds to desirability of multiple-unit system for suburban operation.

Norway. The Electrified Cristiania-Drammenbrane Line (Den elektriserte Kristiania-Drammenbane), Hj. Schreiner. Teknisk Ukeblad, vol. 69, nos. 28 and 29, July 14 and 21, 1922, pp. 263–267 and 273–277, 13 figs. Connecting arrangements, overhead lines, locomotives, transformer stations; wiring diagrams.

Switzerland. Electric Traction on the St. Gothard Line (La trazione elttrica sull'intiera linea del Gottardo). Rivista Tecnica della Svizzera Italiana vol. 11, no. 6, June 1922, pp. 64–69. Advantages of electric traction; hydroelectric works; substations; electric locomotives; etc.

ELECTRIC WELDING

Ship Construction. Electric Welding Applied to Steel Construction, with Special Reference to Ships, A. T. Wall. Eng. & Indus. Mangagement, vol. 7, nos. 13 and 15, May 4 and June 1, 1922, pp. 397–399 and 469–472 and vol. 8, no. 2, Aug. 10, 1922, pp. 54–55, 14 figs. Present practice and future possibilities; necessary precautions.

Welding Car. Construction and Use of an Electric Welding Car (Construction et emploi d'un poste mobile de soudure electrique), Jacques Schopfer. Industrie des Tramways, vol. 16, no. 184, Apr. 1922, pp. 87–93, 10 figs. Construction and equipment of car which runs along street tracks and is used for welding worn street rails.

ELECTRIC WELDING, ARC

Locomotive Work. Use and Abuse in Electric Arc Welding in Locomotive Work, C. W. Roberts. Am. Welding Soc. Jl., vol. 1, no. 7, July 1922, pp. 9–19, 19 figs. General description and practical data.

Quality and Application. Quality and Application of Electric Arc Welding (Qualitätsuntersuchungen und Verwendungen elektrischer Lichtbogen-Schweissung), Oskar Kjellberg. Autogene Metallbearbeitung, vol. 15, nos. 9, 10, 11, 12 and 13, May 1, 15, June 1, 15 and July 1, 1922, pp. 124–129, 135–143, 149–155, 166–172 and 178–184, 43 figs. May 1:

Describes author's process and its adaptation to meet Lloyd's requirements; also application to shipbuilding. May 15: Marine boilers of Scotch type; electric welding rules of Lloyd's Register. May 15, June 1, 15 and July 1: Discussion.

ELECTRIC WELDING, RESISTANCE

Nomenclature. Terms Used in Electric Welding. Ry. Jl., vol. 28, no. 9, Sept. 1922, pp. 18–19. Nomenclature report made by resistance welding committee of Am. Bur. of Welding.

EMPLOYMENT MANAGEMENT

Employee Suggestion Plans. Employee Suggestion Plans, Sanford DeHart. Am. Mach., vol. 57, no. 10, Sept. 7, 1922, pp. 365–367. Reward for suggestions in money and promotion. How priority of suggestions is determined. Some successful plans in practice.

Personnel Records. Visualizing Potential Occupations, Ralph W. Immel. Management Eng., vol. 3, no. 3, Sept. 1922, pp. 143–146, 2 figs. Describes and illustrates form of personnel record sheet.

ENGINEERING

Status of Profession. The Proper Status of the Engineering Profession, R. A. Hart. Chem. & Met. Eng., vol. 27, no. 6, Aug. 9, 1922, pp. 245–248. Sets forth ideals toward which individual engineers must strive, and examines critically shortcomings of present-day engineer.

ENGINEERING SOCIETIES

Federated American Engineering Societies. A Lay View of the Function of the Federated American Engineering Societies. Min. & Metallurgy, no. 189, Sept. 1922, pp. 29–31. Reprint of closing chapter entitled Science and Engineering of Prof. Cassius J. Keyser's work, Mathematical Philosophy.

ENGINEHOUSES

Turntables. Twin Span Turntable Reduces Load on Center. Ry. Age, vol. 73, no. 9, Aug. 26, 1922, pp. 383–385, 5 figs. Describes turntable having two separate girder spans with simple bearings at center; operation becomes largely independent of ordinary settlement of center or variations in level of circular rail.

EVAPORATION

Liquid into Gas. The Evaporation of a Liquid into a Gas, W. K. Lewis. Mech. Eng., vol. 44, no. 7, July 1922, pp. 445–446. Investigates mechanism of evaporation of liquid into gas as applied to such processes as are found in gas scrubbers, humidifiers, dehumidifiers, water coolers, air driers, etc. Establishes formula for calculating humidity of air from wet- and dry-bulb thermometer readings. (Abridgment.)

EXHAUST STEAM

Utilization. Exhaust-Steam Utilization (Abwärme-Verwertung), M. Hottinger. Schweizerische Bauzeitung, vol. 80, nos. 3, 4 and 5, July 15, 22 and 29, 1922, pp. 31–32, 37–41 and 52–54, 17 figs. July 15: Heat balance of a steam engine plant; diagrams and tables on steam consumption of turbines and piston engines. July 22: Utilization of waste and intermediary steam. July 29: Exhaust-steam utilization from steam hammers and similar arrangements.

F

FEEDWATER HEATERS

Locomotive. Feed Water Heaters for Locomotives. Boiler Maker, vol. 22, no. 7, July 1922, pp. 196–197. Statistical data on use and tests of locomotive feed-water heaters. From report before Am. Ry. Assn.

Feed Water Heating and Boiler Circulating Apparatus for Locomotives. Ry. Gaz., vol. 37, no. 6, Aug. 11, 1922, pp. 198–202, 10 figs. Describes systems for heating boiler feedwater by flue gases and exhaust steam, either separately or in combination.

FLAME PROPAGATION

Vapor-Air Mixtures. Limits for the Propagation of Flame in Vapour-Air Mixtures, Albert G. White. Chem. Soc. Jl., vol. 122, July 1922, pp. 1244–1270, 2 figs. Mixtures of air and one vapor at ordinary temperature and pressure.

FLIGHT

Motorless. Motorless Flight Impossible as Transportation Means, Edward P. Warner. Automotive Industries, vol. 47, no. 11, Sept. 14, 1922, pp. 530–531. Air sailing or gliding promises significant developments in aeronautics. Describes European competitions.

FLOUR MILLS

Modern. A Modern Flour Mill. Engineer, vol. 133, nos. 3466, 3467, 3468 and 3469, June 2, 9, 16 and 23, 1922, pp. 616–617, 12 figs. partly on p. 612, 627–629, 8 figs., 664–666, 10 figs. and 687–688, 4 figs. Detailed description of complete system of flour milling as practiced by Millennium Mills, Victoria Dock, London, and illustrations of some of principal machines employed.

FLOW OF FLUIDS

Condensation in Return Pipes. Theory for the Flow of Condensation in Return Pipes, R. V. Frost. Am. Soc. Heat. & Vent. Engrs. Jl., vol. 28, no. 6, Sept. 1922, pp. 655–659 and (discussion) pp. 659–663. Factors affecting proportions of return pipes.

FLOW OF GASES

Venturi Tubes. Venturi Tubes and Orifices for Bulk Gas Measurement, Johnstone-Taylor. Am. Gas Jl., vol. 117, no. 7, Aug. 12, 1922, pp. 139–141 and 144, 4 figs. With special reference to British practice.

FLOW OF LIQUIDS

Cones. Liquids Flowing Through Cones, W. N. Bond. Physical Soc. of Lond. Proc., vol. 34, part 5, Aug. 15, 1922, pp. 187–196, 7 figs. Consideration of pressure gradient in liquid that flows through conical tube. Results of experiments.

Laminary and Turbulent. Investigations of Laminary and Turbulent Flow (Untersuchungen über laminare und turbulente Strömung), L. Schiller. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 248, 1922, 36 pp., 29 figs. Results of investigations carried out in Inst. for Applied Mechanics of University of Göttingen.

FLOW OF WATER

Channels. The Flow of Water in Open Channels (Ueber die Bewegung des Wassers in Offenen Gerinnen), Armin Schoklitsch. Schweizerische Bauzeitung, vol. 80, no. 5, July 29, 1922, pp. 47–50, 7 figs. Results of author's measurements of pulsations. Behavior of flowing water in vicinity of wall and on surface.

The Correlation of Momentum and Energy Changes in Steady Flow With Varying Velocity and the Application of the Former to Problems of Unsteady Flow or Surges, in Open Channels, Raymond D. Johnson. Engrs. & Eng., vol. 39, no. 7, July 1922, pp. 233–240, 9 figs.

FORGING

Header Machine. Header Machine Makes Forgings, H. E. Diller. Iron Trade Rev., vol. 71, no. 10, Sept. 7, 1922, pp. 643–645 and 650, 7 figs. Intricate parts formerly made on power hammer now are pressed into shape on an upsetting machine. Pole piece is forged in one operation and ring gear in three.

FOUNDATIONS

Concrete Stresses in. Stresses in Concrete Foundations (Die Beanspruchungen in Betonfundamenten), W. Gehler. Bauingenieur, vol. 3, nos. 14 and 15, July 31 and Aug. 15, 1922, pp. 421–427 and 456–462, 23 figs. The sliding surfaces of concrete bodies are investigated and calculated with aid of the Mohr stress diagram. Based on model tests with concrete blocks, origin of cracks in structures is explained and safety measures are recommended.

Machinery. The Foundations for High-Power Engines (Fundamente für Grosskraftmaschinen), August Wolfsholz. Zeit. des Vereines deutscher Ingeneieure, vol. 66, no. 31–32, Aug. 12, 1922, pp. 773–776, 19 figs. Gives example of modern highly stressed engine foundation. Failures of old foundations and their causes; reconstruction. Suggestions for building crack- and break-proof foundations with aid of pressed concrete piles, construction of which is described.

Pressure Transmission through Soils. Transmission of Pressure through Solids and Soils and the Related Engineering Phenomena, George Paaswell. Am. Soc. Civ. Engrs. Proc., vol. 48, no. 5, May 1922, pp. 1075–1089, 8 figs. It is shown that, in restricted sense, present-day rule-of-thumb methods of assumed stress paths hold true. Deals with two types of materials, namely, true granular, such as ordinary soils, and concrete aggregates, such as rock soils and concrete materials.

FOUNDRIES

Bronze. The Bronze Foundry (La Fonderie de Bronze), Derdinger. Fonderie Moderne, no. 7, July 1922, pp. 9–20 and (discussion) 21–24, 11 figs. Detailed discussion of organization of modern bronze foundry; layout, equipment, furnaces, sand, alloys, treatment of slag, illumination, etc.

FREIGHT HANDLING

Motor-Truck. Development and Future of Motor Truck Freight Handling, F. W. Fenn. Automotive Mfr., vol. 64, no. 4, July 1922, pp. 15–17. Present situation at freight terminals and ability of motor truck to relieve congestion and open up new country. Particular reference to reducing terminal cost of handling less than car load.

Terminal. Terminal Relief by Direct Freight Delivery. Ry. Age, vol. 73, no. 12, Sept. 16, 1922, pp. 514–516. Successful system necessitates complete coöperation of railroad shipper and responsible trucking medium. Abstract of talks before Soc. Terminal Engrs.

Veri-Direct Method. The Veri-Direct Method of Loading L.C.L. Freight, C. G. Johnson. Railroad Herald, vol. 26, no. 9, Aug. 1922, pp. 29–33. Also discusses veri-check record of handling inbound freight effective at larger stations on Ohio region of Erie Railroad.

FUELS

Colloidal. Colloidal Fuel, Lindon W. Bates. Steam, vol. 30, no. 2, Aug. 1922, pp. 41–44. Outline of nature of colloidal fuel and its relation to railway systems of United States.

Heating Values. Thermo-Calorimetric Heating Values of Fuels, J. Hudler. Mech. Eng., vol. 44, no. 9, Sept. 1922, pp. 596–597, 3 figs. Author indicates method for determining heating value of fuels which he claims is superior to straight calorimeter method. Translated from Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 20, May 20, 1922, pp. 495–497.

Refuse. Power from Refuse in Britain, C. H. S. Tupholme. Power Plant Eng., vol. 26, no. 17, Sept. 1, 1922, pp. 853–854. Producer gas mode from factory and dust-bin refuse used in gas engines and boiler furnaces.

Wood Waste, Gasification of. Utilization of Wood Refuse through Gasification (Verwertung der Holzabfälle durch Vergasung), Hans Neumann. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 31–32, Aug. 12, 1922, pp. 757–763, 23 figs. Review of wood-gasification plants; the Deutzer double producer with tar-washing plant and practical results obtained therewith; wood-gasification plant of the Liusen-Woxna Works. Relative economy of wood-burning furnaces and wood-gasification plants for power supply of saw mills with regard to waste-heat utilization, tar recovery and wood residue.

[See also PULVERIZED COAL.]

FURNACES, BOILER

Air Spraying of Fuel. Air-Spraying the Fuel. Practical Engr., vol. 66, no. 1848, July 27, 1922, pp. 52–53, 2 figs. Describes apparatus known as "air-spray" for ensuring complete combustion of fuel.

Plate Thickness. Chart for Boiler-furnace Plate Thickness, Arnold A. Arnold. Mech. World, vol. 72, no. 1859, Aug. 18, 1922, pp. 118–119, 2 figs. Presents chart based on formulas applicable to plain furnaces or boiler flues given in latest rules for boiler strengths issued by (Brit.) Board of Trade under title, Standard Conditions for the Design and Construction of Marine Boilers.

Volumetric Dimensions. The Volumetric Dimensions of Boiler Furnaces. Engineer, vol. 134, no. 3479, Sept. 1, 1922, pp. 217–218. Notes on large combustion chambers and use of pulverized fuel; question of furnace volume and boiler design.

FURNACES, HEATING

Continuous. Continuous Heating Furnaces for Steel, W. E. Groume-Grjimailo. Iron Age, vol. 110, no. 8, Aug. 24, 1922, pp. 465–467, 8 figs. Importance of careful attention to roof slope; flow of gases outlined to prevent uneven heating of ingots or billets. (Abstract.) From The Flow of Gases in Furnaces, Wiley & Co., translated by A. D. Williams.

Regenerative. Regeneratively Fired Heating Furnaces, W.-E. Groume-Grjimailo. Iron Age, vol. 110, no. 9, Aug. 31, 1922, pp. 537–538, 4 figs. Conditions necessary for freeing hearth of waste gases. Good and bad examples. Translated from The Flow of Gases in Furnaces, published by Wiley & Co.

FURNACES, METALLURGICAL

Heat Losses. Calculating Heat Losses in Furnaces, O. I. Hansen. Blast Furnace & Steel Plant, vol. 10, no. 8, Aug. 1922, pp. 437–440, 1 fig. New method for determination of heat losses due to incomplete combustion. Translated from Danish.

Types. Metallurgical Furnaces (Les Fours métallurgiques), Sigma. Métallurgie, vol. 54, nos. 11 and 12, Mar. 16 and 23, 1922, pp. 401–402 and 437–439. Mar. 16: Furnaces for solid, liquid and gaseous fuel; electric, blast, and reverberatory furnaces. Mar. 23: Recuperation in various types.

G

GAGES

Screw-Thread. Heat Treatment of Screw Gauges. Eng. Production, vol. 5, no. 97, Aug. 10, 1922, p. 138. Résumé of experimental work conducted over period of nine months with view to determining best conditions for production of hardened screw gages to satisfy stringent tests of Nat. Physical Laboratory.

Some Notes on Hardening Various Screw Gauges, F. A. Livermore. Can. Machy., vol. 28, no. 2, July 13, 1922, pp. 26–27. Results of experimental work; effort to obtain process that will eliminate warpage and change of shape; methods of heat treating and quenching; expansion and contraction.

GALVANIZING

Heat Transmission. Heat Transmission in the Hot-Galvanizing Process—II, J. D. Keller. Blast Furnace & Steel Plant, vol 10, no. 8, Aug. 1922, pp. 407–411, 4 figs. Describes temperature distribution of process.

GAS PRODUCERS

Ash-Fusion. An Ash-Fusion Producer, M. Rivière. Gas Jl., vol. 159, no. 3093, Aug. 23, 1922, pp. 424–425, 1 fig. Describes Marconnet producer for gasification of coke breeze. Translated from paper read before Société Technique du Gaz.

Körting. The New Körting Gas Producers (Die neuen Körting-Gaserzeuger), H. Pradel. Wärme, vol. 45, no. 29, July 28, 1922, pp. 356–357, 4 figs. Details of two new types of producers for burning of low-grade fuel, for suction-gas operation, and with tar-recovery plant. One is revolving-grate type.

GAS TURBINES

Hepburn-Forbes System. The Internal Combustion Turbine, W. A. D. Forbes. Engineer, vol. 134, no. 3479, Sept. 1, 1922, pp. 224–225, 2 figs. Comparison of types and efficiencies. Description of new system of operation proposed by author and H. A. Hepburn, based on new theory of nozzle action and involving use of novel type of pump, known as kinetic compressor.

Problem. The Problem of the Internal Combustion Turbine. Mar. Engr. & Nav. Architect, vol. 45, no. 539, Aug. 1922, pp. 297–299, 1 fig. Comparison of temperature conditions in internal-combustion turbine and reciprocating engine. Internal-combustion turbine a possible economic intermediary between and Diesel engines.

GASOLINE

Synthetic. Progress in Synthetic-Gasoline Production, Roy Cross. Mech. Eng., vol. 44, no. 9, Sept. 1922, pp. 593–595 and 621, 3 figs. Particulars regarding processes employed. Results of tests of improved synthetic-crude system. Comparative costs of manufacturing gasoline by different processes. (Abridgment.)

GEAR CUTTING

Hobbing. Rapid Production of Gears by Hobbing Process. Can. Machy., vol. 28, no. 7, Aug. 17, 1922, pp. 26–27, 6 figs. Continuous cutting movement; one passage of hob completes gear; even distribution of generated heat; special arbors for different types of blanks; automatic indexing.

GEARS

Calculation. Calculation of Wheel Gears (Berechnung von Rädergetrieben), Rud. Böttger. Maschinenbau, vol. 1, no. 7, July 8, 1922, pp. 426–430, 7 figs. Equations are developed for calculation of pressure at pitch line of spiral gears.

Calculation of Tooth Wheels (Berechnung von Zahnrädern). Zeit. für die gesamte Giessereipraxis, vol. 43, nos. 28 and 29, July 22 and 29, 1922, pp. 391–393 and 408–409, 4 figs. Dimensions of teeth and their parts, and of wheels. Calculations.

Nomenclature and Rules for Laying out the Teeth of Spur and Bevel Gears. (Bezeichnungen und Vorschriften für die Verzahnung von Stirn- und Kegelrädern), K. Kützbach. Maschinenbau, vol. 1, no. 7, July 8, 1922, pp. 412–422, 25 figs. Problem for every kind of involute gear is solved. Preliminary work for standardization of gears.

Helical and Spur. Helical Gears and Spur Gears—III, W. G. Dunkley. Machy. (Lond.), vol. 20, no. 515, Aug. 10, 1922, pp. 578–580, 8 figs. Load variation of spur gears compared with helical gears; relative variation in periodical velocity transmission; conditions affecting relative efficiencies; effect of tooth inaccuracies.

Involute. Equalization of the Natural Errors in Involute Toothed Gears by Use of Standard Helicoidal Tools (Ausgleich der natürlichen Fehler von Evolventen-Zahnradgetrieben—bei Anwendung normaler Abwälzwerkzeuge), E. Toussaint. Maschinenbau, vol. 1, no. 7, July 8, 1922, pp. 401–412, 26 figs. Describes method developed by author and its advantages.

Long-Addendum. Lewis Constants Determined for Long Addendum Gears, P. M. Heldt. Automotive Industries, vol. 47, no. 5, Aug. 3, 1922, pp. 219–221, 5 figs. Method of obtaining value of constants for full-strength formula. Long addendum principle of value only in large reduction sets.

Methods of Forming Teeth. Different Methods of Forming Gear Teeth Profiles, C. B. Hamilton, Jr. Can. Machy., vol. 27, no. 21, May 25, 1922, pp. 23–24. Grinding process seldom used except for worms; producing thin gears in punch press; classification according to tooth shape; involute system in general practice.

Pump, Tooth Shapes. Tooth Shapes for Pump Gears, A. Fisher. Machy. (Lond.), vol. 20, no. 517, Aug. 24, 1922, pp. 633–634, 5 figs. Features of design to secure increased capacity.

Tooth-Chamfering Machine. A Gear Tooth Chamfering Machine. Eng. Production, vol. 5, no. 100, Aug. 31, 1922, pp. 194–195, 6 figs. Details of Parkinson machine which deals with gears up to 15-in. diameter by 5 diametral pitch and can mill single or double chamfer.

GLASS MANUFACTURE

Plants. New Plant of the United States Sheet and Window Glass Company at Shreveport, Louisiana, J. B. Krak. Glass Industry, vol. 3, no. 9, Sept. 1922, pp. 171–180, 19 figs. Description of buildings and equipment.

Tank Furnaces. The Production of Colourless Glass in Tank Furnaces with Particular Reference to the use of Selenium. Soc. of Glass Technology Jl., vol. 6, no. 22, Aug. 1922, pp. 168–181. Experimental results.

GRINDING

Automobile Parts. Grinding Ford Motor Car Parts, Fred B. Jacobs. Abrasive Industry, vol. 3, no. 8, Aug. 1922, pp. 231–237, 13 figs. Describes methods employed. Fixed-wheel principle employed extensively in finishing great variety of cylindrical work.

Grinding in the Automobile Industry. Machy. (Lond.), vol. 20, no. 517, Aug. 24, 1922, pp. 625–630, 12 figs. Methods of grinding steel balls, ball-bearing races, roller-bearing cups, cones and rollers.

Iron and Steel. Investigates Grinding of Steel, H. W. Wagner. Iron Trade Rev., vol. 71, no. 7, Aug. 17, 1922, pp. 444–446, 2 figs. Tests show effects of heat and mechanical treatment and chemical composition of iron and steel on grinding-wheel action. Finds manganese steel grinds readily when forced despite toughness.

Small-Tool Industry. Grinding in the Small Tool Industry. Machy. (N. Y.), vol. 29, no. 1, Sept. 1922, pp. 45–51, 19 figs. Grinding straightedges; sharpening cutters; grinding plug gages, micrometer parts, twist drills, taps and dies, lathe and planer tools.

GUNNERY

Gunsight Manufacture. Some Unique Operations in the Manufacture of Gunsights. Am. Mach., vol. 57, no. 8, Aug. 24, 1922, pp. 281–286, 17 figs. Delicate parts involve special machines and methods; fixtures and tools developed for work; automatic "digging" machine.

H

HANDLING MATERIALS

Chemical Plants. Increased Production Efficiency Means Good Material Handling, J. G. Hatman. Chem. & Met. Eng., vol. 27, no. 9, Aug. 30, 1922, pp. 396–399. Material-handling problem in chemical plant; analysis of problem and suggestions toward solution; advantages derived from good methods.

Iron and Steel Industry. Material-Handling Equipment as Used in the Iron and Steel Industry, F. L. Leach. Mech. Eng., vol. 44, no. 8, Aug. 1922, pp. 493–499, 14 figs. Describes handling machinery and apparatus used in manufacture of steel. (Abstract.)

Rotary Tank Cars. Handling Bulk Materials of Various Kinds by Compressed Air and Rotary Tank Cars, Rudolph Welcker. Compressed Air Mag., vol. 27, no. 8, Aug. 1922, pp. 230–232, 3 figs. Design of rotary tank car. Detail of methods of loading and discharge.

Textile Mills. Mechanical Handling of Materials in Textile Plants, Charles M. Mumford. Engrs. & Eng., vol. 39, no. 8, Aug. 1922, pp. 282–288, 12 figs. Describes system for conveying stock in process which does work of many men who were formerly employed in trucking between departments.

Tiering Machines. Adapting the Tiering Machine to Industry, Matthew W. Potts. Management Eng., vol. 3, no. 3, Sept. 1922, pp. 155–160, 11 figs. Applications to storage, transportation and manufacturing.

Transporter for Printing Works. Transporting Appliances for a Printing Works. Engineering, vol. 114, no. 2956, Aug. 25, 1922, pp. 234–236, 16 figs. Details of electrically driven transporter erected at a London printing works for carrying reels and flat bundles of paper to paper stores from lorries or vans standing in street, or from paper stores to printing machines.

HANGARS

Airline, Elimination of. Eliminating the Airline Hangar, Archibald Black. Aviation, vol. 13, no. 8, Aug. 21, 1922, pp. 221 and 224, 2 figs. Reducing investment in buildings and overhead by mooring weather-proof airplanes in open.

HARMONIC ANALYSIS

Wave Forms. Harmonic Analysis by Selected Co-Ordinates, Albert E. Clayton. Elecn., vol. 89, no. 2309, Aug. 18, 1922, pp. 176–179, 6 figs. New form of schedule for analysis of wave forms.

HEAT

Conductivity. The Derivation of True Thermal Conductivity Coefficient from Overall Test Results, P. Nicholls. Am. Soc. Heat. & Vent. Engrs. Jl., vol. 28, no. 6, Sept. 1922, pp. 665–677 and (discussion) pp. 677–682, 8 figs. Method is developed for deriving curve of conductivity coefficient against temperature. Report of coöperative work of this Society and U. S. Bur. of Mines Experiment Station, Pittsburgh.

HEAT PUMPS

Process and Applications. The Heat Pump, T. B. Morley. Engineer, vol. 134, no. 3472, July 14, 1922, pp. 27–29, 5 figs. In heat-pump process vapor from evaporator is taken to a compressor, in which its pressure, and hence also its temperature, are raised to such a degree that the compressed vapor may serve as heating medium in evaporator. Details and application of heat pump.

HEAT TRANSMISSION

Buildings, Measuring Heat Flow in. Measuring the Flow of Heat in Buildings by Means of Resistance Wires, F. E. Giesecke. Heat. & Vent. Mag., vol. 19, no. 8, Aug. 1922, pp. 29–31, 5 figs. Account of tests made in cold storage building of Lone Star Ice Co., Austin, Tex.

HEATING AND VENTILATING

Detroit Junior High School. Mechanical Equipment of the Intermediate or Junior High School in Detroit. H. W. Anderson. Heat. & Vent. Mag., vol. 19, no. 7, July 1922, pp. 38–43, 9 figs. Details of "projection" method of air distribution, with ceiling fresh air outlets, as adopted in Barbour schools. From paper and before Am. Soc. Heat. & Vent. Engr.

HEATING, HOT-WATER

Steam-Jet Apparatus. Investigations of Steam-Jet Apparatus (Untersuchungen an Dampfstrahlapparaten), F. Heinl. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 256, 1922, 23 pp., 21 figs. Investigations to determine following questions: degree of water heating obtained under most favorable working conditions with given steam-supply conditions and discharge pressure; behavior of steam-jet apparatus with change of their normal water volume.

HEATING, STEAM

Exhaust Steam for. Recent Data on Exhaust Steam for Heating. Heat. & Vent. Mag., vol. 19, no. 7, July 1922, pp. 35–38, 17 figs. Records of operation in office buildings and hotels in New York City made basis of new coal consumption charts.

HELICOPTERS

Problems and Development. The Helicopter and the Variable Pitch Propeller. Mech. Eng., vol. 44, no. 9, Sept. 1922, pp. 575–578, 5 figs. Notes on problems involved and present situation of development, particularly in United States.

Theory. The Problem of the Helicopter, Edward P. Warner. Nat. Advisory Committee for Aeronautics Technical Notes, no. 4, May 1920, 18 pp., 2 figs. and 2 blue prints. Theory of direct-lifting screw propeller; safety of helicopters in forced descents; horizontal travel; stability and control of helicopter; results of tests.

HOISTS

Framework. New Reinforced-Concrete Winding Frames. (Neue Fördertürme und Fördergerüste in Eisenbetan), F. Kögler. Glückauf, vol. 58, no. 30, July 29, 1922, pp. 917–922, 12 figs. Describes new types with and without struts. Desiderata for construction of such frames.

HYDRAULIC TURBINES

Design. The Hydraulic Turbine in Evolution, H. Birchard Taylor and Lewis F. Moody. Engrs. & Eng., vol. 39, no. 7, July 1922, pp. 241–259, 15 figs. Problems created by turbine evolution; some mechanical and hydraulic problems in design of high-speed turbines; efficiencies attained in turbines now developed; analysis of flow in high-speed turbines; influence of turbine speed on setting and station structure.

Manitoba Power Co. Turbines for the Great Falls Development of the Manitoba Power Company, H. S. Van Patter. Eng. Jl. (Eng. Inst. Can.), vol. 5, no. 9, Sept. 1922, pp. 461–464, 5 figs. Special features of 28,000-hp. I. P. Morris turbines installed in this plant.

Water Admission with Shock. Loss Caused by Shock with Admission of Water in Turbine Blade (Der "Stossverlust" des Wassers beim Eintritt in Schaufelsysteme), D. Thoma. Schweizerische Bauzeitung, vol. 80, no. 8, Aug. 19, 1922, pp. 83–84, 4 figs. Formula is derived for calculation of loss of hydraulic pressure head.

HYDROELECTRIC DEVELOPMENTS

Austria. Economics and Development of Hydro-electric Plants in Austria (Wirtschaftlichkeit und Ausbau der Wasserkraftanlagen in Oesterreich), L. Rosenbaum. Zeit. des Oesterr. Ingenieur-u. Architekten-Vereines, vol. 74, no. 31–32, Aug. 4, 1922, pp. 150–152. Development in Austrian Empire until 1914, development in Austrian Republic, 1920; and projects for Republic to be completed in 1935.

Cameron Falls, Canada. Hydro-electric Development at Cameron Falls, Nipigon River, Ontario. Elec. News, vol. 31, no. 15, Aug. 1, 1922, pp. 40–44, 10 figs. Power house and electrical equipment. First two units of ultimate capacity totaling 75,000 hp. installed. See also Contract Rec., vol. 36, no. 31, Aug. 2, 1922, pp. 780–784, 10 figs.

Colorado. Future of Hydro-Electric Generation in Colorado, Herbert B. Dwight. Elec. World, vol. 80, no. 5, July 29, 1922, pp. 215–218, 5 figs. Many large power sites and other resources of great potentiality await development; principal factor delaying development is inadequate transportation.

Economics. Economics of Water-Power Development, Curtis A. Mees. Mech. Eng., vol. 44, no. 7, July 1922, pp. 431–434, 1 fig. Discusses production, maintenance and selling costs and fixed charges. Business hazards and unrecoverable losses.

Queenston-Chippawa, Canada. Queenston-Chippawa Power Development. Engrs. & Eng., vol. 39, no. 8, Aug. 1922, pp. 292–301, 8 figs. Article on general and economic features, by H. G. Acres, and article on electrical features, by Edgar T. J. Brandon.

Scotland. The Grampian Hydro-Electric Scheme. Engineer, vol. 133, no. 3465, May 26, 1922, pp. 571–573, 1 fig. Discusses bill before Parliament to develop extensive scheme in Scotland, involving total watershed area of 418 sq. mi., and to install plant of sufficient capacity to generate 56,000 hp. continuously.

HYDROELECTRIC PLANTS

Canada. Nipigon Hydro-Electric Power Development. Can. Engr., vol. 43, no. 5, Aug. 1, 1922, pp. 214–216, 4 figs. Description of plant at Cameron Falls, Ont.

Design. Hydroelectric Power-Plant Design, J. A Sirnit. Mech. Eng., vol. 44, no. 8, Aug. 1922, pp. 505–508, 8 figs. Describes Thurlow backwater suppressor utilizing waste water for removal of high tail water from discharge opening during flood periods. Describes two testing models and design of draft-tube orifice. Details of construction and equipment of plant of Ala. Power Co. at Mitchell Dam, Ala.

Hazards. Hazards in Hydroelectric Plants, Alex. E. Bauhan. Gen. Elec. Rev., vol. 25, no. 9, Sept. 1922, pp. 526–537, 10 figs. Some hydraulic and mechanical hazards present in operation of low-head hydro-electric plant and precautions which may be taken to avoid them.

Kern Canyon, Cal. How a 3,000-Kw. Hydro-Electric Plant Was Rebuilt to Develop 9,000 Kw., H. K. Fox and B. F. Jacobsen. Elec. World, vol. 80, no. 7, Aug. 12, 1922, pp. 315–318, 6 figs. Unusual construction difficulties and peculiar features of electrical installation.

Queenston-Chippawa, Canada. Queenston-Chippawa Development. Power Plant Eng., vol. 26, no. 15, Aug. 1, 1922, pp. 760–767, 12 figs. General description including generator units and accessories.

The Queenston-Chippawa 600,000-Hp. Hydro-Electric Station. Power, vol. 56, no. 8, Aug. 22, 1922, pp. 270–278, 19 figs. Describes headworks, penstocks, power house and electrical equipment.

Winnipeg, Can. Extensions to the Hydro-Electric System of the City of Winnipeg, E. V. Caton. Eng. Jl. (Eng. Inst. Can.), vol. 5, no. 9, Sept. 1922, pp. 441–444, 4 figs. Additional units installed in Point du Bois plant, on Winnipeg River.

I

ICE PLANTS

Raw-Water. An Interesting Raw-Water Ice Plant. Southern Engr., vol. 38, no. 1, Sept. 1922, pp. 64–67, 11 figs. Describes 40-ton can ice plant consisting of 40-ton horizontal belt-driven ammonia compressor, and its operation. Practically all operations are automatically performed and clear ice is manufactured.

IGNITION

Automobiles. What Are the Essentials of a Good Ignition System? C. H. Kindl. Automotive Industries, vol. 47, no. 11, Sept. 14, 1922, pp. 516–518, 8 figs. Briefly touches on some problems connected with high-tension ignition which are of interest to automotive engine manufacturers. Ability of system to fire plugs under adverse conditions, and igniting quality of spark are important; also reliability, longevity and effect on engine performance.

IMPACT TESTING

Development. Symposium on Impact Testing of Materials. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 107 pp., 34 figs. Review of development of impact testing of materials and discussion of significance and value of impact test.

INDUSTRIAL MANAGEMENT

Bedaux Methods. Application of Bedaux Management Methods in the Robbins & Myers Plants, L. C. Morrow. Am. Mach., vol. 57, nos. 7 and 8, Aug. 17 and 24, 1922, pp. 249–255 and 294–298, 12 figs. Aug. 17: Estimating, manufacturing, inspection and salvage; reports and graphs. Aug. 24: Time studies; premium for inspection; reports and graphs.

Planning Department. Practical Work Planning, G. M. Bryceson. Eng. Production, vol. 5, no. 100, Aug. 31, 1922, pp. 206–209, 7 figs. System for determining and recording machine-hour capacity of each department and subdividing this into machine-hour capacity for each type of machine in the various sections.

Production Records. Records as a Basis for Management, B. A. Franklin. Management Eng., vol. 3, no. 3, Sept. 1922, pp. 133–137. Discusses task of executive; pictures of costs, prices and profits; specifications for a record; standards or measuring rules; scope of records; records of information and control.

Textile Plants. Management Applied to Textile Plants, George S. Harris. Mech. Eng., vol. 44, no. 6, June 1922, pp. 382–384. Organization of cotton plant and its management. Comparison of cotton-manufacturing development in North and South.

INDUSTRIAL ORGANIZATION

Public Office. Organizing a Public Office to Conduct a $20,000,000 Building Program, Norris M. Perris. Management Eng., vol. 3, no. 3, Sept. 1922, pp. 147–153, 1 fig. It is claimed that saving of $30,000 in a $330,000 pay-roll was made in one year by increasing quantity production, and salaries were increased 25 per cent. Presents plan of new organization.

INDUSTRIAL RELATIONS

Delco Policy. An Industrial Relations Policy That Makes Production Cost Less, Harry Tipper. Automotive Industries, vol. 47, no. 10, Sept. 7, 1922, pp. 473–476, 2 figs. Practice of Dayton Eng. Laboratories Co. Personal grievances are constructively met by interview and adjustment. Social activities encouraged, but operated entirely by employees. Small items and trifles considered important.

INDUSTRIAL TRUCKS

Gas-Operated. A Gas-Operated Industrial Truck with Elevating Platform. Ry. Age, vol. 73, no. 6, Aug. 5, 1922, p. 263, 2 figs. Has platform 54 in. by 26 in. with 11 in. minimum height above floor, which can be raised to 16 in. by lifting mechanism.

INSULATING MATERIALS

Thermal Conductivity. Measurement of The Thermal Conductivity of Liquids, Insulating Materials and Metals (Messung des Wärmeleitvermögens von Flüssigkeiten, Isolierstoffen und Metallen), Max Jakob. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 27, July 8, 1922, pp. 688–693, 4 figs. Measurements on liquids and poor heat conductors (solid); and on metals and alloys.

INTERCHANGEABLE MANUFACTURE

Inspection. Control of Quantity Production (Vérification d'une fabrication de pièces en grande série), Danty-Lafrance. Vie Technique et Industrielle, vol. 3, nos. 33 and 34, June and July 1922, pp. 154–158 and 245–248, 7 figs. Necessity for rigid control and inspection in manufacture of interchangeable parts; tolerances allowable; inspection of general forms and threads; control of work done by inspecting staff.

INTERNAL-COMBUSTION ENGINES

Compound. Compound the Combustion Engine. Mech. Eng., vol. 44, no. 8, Aug. 1922, pp. 525–527 and 554, 1 fig. Discussion of paper by Elmer A. Sperry, presented before A.S.M.E.

Frictional Losses. A New Method for Determining Engine Friction Losses. Automotive Industries, vol. 47, no. 8, Aug. 24, 1922, p. 369. Method developed by G. Lumet based on idea that friction couple varies with engine torque and consequently with mean effective pressure.

Fuel Detonation. Detonation Characteristics of Blends of Aromatic and Paraffin Hydrocarbons, Thos. Midgley, Jr. and T. A. Boyd. Jl. Indus. & Eng. Chem., vol. 14, no. 7, July 1922, pp. 589–593, 3 figs. Results obtained in careful measurement of effects of various concentrations of benzene, toluene, or xylene upon detonation tendency of paraffin fuels in badly carbonized or high compression engines.

Future of. The Future Automotive Engine (Der künftige Verkehrsmotor), Gg. Bergmann. Motorwagen, vol. 24, nos. 26 and 29, Sept. 20 and Oct. 20, 1921, pp. 538–541 and 643–646, 10 figs. and vol. 25, nos. 2 and 7, Jan. 20 and Mar. 10, 1922, pp. 23–25 and 128–133, 8 figs. Scope and limitations of internal-combustion, Diesel and semi-Diesel and light airplane engines. Blowing engines. Comparison of explosion and internal-combustion engines.

Grote Two-Stroke. The Grote Two-Stroke Engine (Der Grote Zweitaktmotor), Paul H. Weise. Motorwagen, vol. 25, no. 19–20, July 10–20, 1922, pp. 372–374, 2 figs. Said to combine advantages of four-cycle with those of two-cycle engines, and to effect saving in fuel consumption.

Ignition. See IGNITION.

Marine. Comparison of Internal-Combustion Marine Engines, Two- and Four-Stroke (Comparaison des moteurs marine à combustion interne, à deux et quatre temps), Legrand-Ribet. Outillage, vol. 6, no. 30, July 29, 1922, pp. 930–931, 4 figs. Construction and operation; advantages of two-stroke as to weight, regularity of motion, facility of operation, etc.

Steel-Plant Power Generation. Internal Combustion Engines for Power Generation in Steel Plants, D. M. Petty. Assn. Iron & Steel Elec. Engrs., vol. 4, no. 9, Sept. 1922, pp. 659–571, 5 figs. Describes 4-cylinder, 4-cycle double-acting gas engine and 4.6 or 8-cylinder, 2-cycle Diesel oil engine. Analysis of first cost and cost of operation.

Valve Action. Valve Actions in Relation to Internal-Combustion Engine Design, Chester S. Ricker and John C. Moore. Soc. Automotive Engrs. Jl., vol. 11, no. 3, Sept. 1922, pp. 284–289 and (discussion) 289–291, 11 figs. Results obtained from combined road and laboratory tests made to determine amount of power required to maintain given car speed. Discusses manifold gas velocity.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; OIL ENGINES.]

IRON

Rustproofing. The Rustproofing of Iron (Wesen und Ziele des Eisenschutzes), Leo Ivanovszky. Eisenbau, vol. 13, no. 7, July 25, 1922, pp. 153–162. With special consideration of so-called self-protection of iron—that is, treatment of iron in its natural state so as to render it rustproof.

IRON ALLOYS

Iron-Carbon. Conditions of Stable Equilibrium in Iron-Carbon Alloys, H. A. Schwartz, H. R. Payne, A. F. Gorton and M. M. Austin. Am. Inst. Min. & Met. Engrs. Trans., no. 1181-S, Aug. 1922, 12 pp., 6 figs. and (abstract) in Min. & Metallurgy, no. 188, Aug. 1922, pp. 38–39, 1 fig. Study of single, impure, iron-carbon alloy carried out in Research Laboratory of Nat. Malleable Castings Co.

IRON CASTINGS

Casting Without Feeding Heads. British Opinions on Making Castings without Feeding Heads. Foundry Trade Jl., vol. 26, no. 313, Aug. 17, 1922, pp. 136–139. Discussion of E. Ronceray's paper published in same journal, June 1.

Making Castings without Feedings Heads, S. G. Smith. Foundry Trade Jl., vol. 26, no. 313, Aug. 17, 1922, pp. 140–141, 1 fig. Refers to paper by E. Ronceray published in same journal, June 1, and discusses possibility of partially or wholly dispensing with feeders, feeding heads and dross heads.

J

JIGS

Manufacture. Some Small Jigs. Engineer, vol. 133, no. 3464, May 19, 1922, pp. 542–545, 12 figs. Methods employed in small tool works of C. A. Vandervell & Co., Brighton, England.

L

LATHES

Auto-Lathes. Reducing Costs on Chucking Work, A. H. Lloyd. Eng. Production, vol. 5, no. 93, July 13, 1922, pp. 26–27, 5 figs. Auto-lathes and their tool equipment.

Driving-Wheel. Driving Wheel Lathe Tests, G. T. R., Stratford Shops. Can. Ry. & Mar. World, no. 294, Aug. 1922, p. 422, 1 fig. Data of tests at Grand Trunk shops, Stratford, Ont., of 90-in. heavy driving wheel lathe. Results given in form of table.

LIQUID AIR

Manufacture and Applications. Liquid Air—Its Manufacture and Applications. Chem. Trade Jl. & Chem. Engr., vol. 71, nos. 1839 and 1840, Aug. 18 and 25, 1922, pp. 189–191 and 221–223, 1 fig. Aug. 18: Theoretical considerations; properties of liquid air; manufacturing methods. Aug. 25: Production of oxygen and nitrogen, argon, helium, neon, and hydrogen; liquid air in explosives manufacture; recent uses.

LOCOMOTIVE BOILERS

Design and Maintenance. Design and Maintenance of Locomotive Boilers. Ry. Age (Daily), vol. 72, no. 24e, June 22, 1922, pp. 1687–1690 and (discussion) 1690–1696, 4 figs. Comparison of radial stay and Belpaire types of construction; investigation of dry pipe situation. A. R. A. Mech. Div. Committee recommendations. See also Boiler Maker, vol. 22, no. 8, Aug. 1922, pp. 223–226, 3 figs.

Mountain-Type Locomotives. Boiler of Union Pacific Mountain Type Locomotive. Boiler Maker, vol. 22, no. 8, Aug. 1922, pp. 217–222, 9 figs. High boiler capacity obtained in 4–8–2 locomotive which is lightest per unit of power ever built.

LOCOMOTIVES

Accessories. New Locomotive Specialties Developed on the Union Pacific. Ry. Rev., vol. 71, no. 3, July 15, 1922, pp. 73–76, 5 figs. Fuller low-water alarm; Fetters drifting valve for superheater locomotives; outside joint for maintaining air-tight joint at intersection of outside steam pipe and smoke box.

Beardmore. Beardmore Locomotives. Ry. Gaz., vol. 37, no. 8, Aug. 25, 1922, p. 258, 4 figs. on p. 259. Dimensions of 2–8–0 heavy goods, 4–6–0 express passenger, 4–8–0 mixed traffic, and 4–6–0 express passenger types.

Booster. Dynamometer Tests of the Locomotive Booster. Ry. Age, vol. 73, no. 12, Sept. 16, 1922, pp. 511–514, 8 figs. Describes booster tested, and test equipment. Severe tests demonstrate reliability at heavy loads and high speeds; maximum drawbar pull 11,000 lb.

Booster for Tender Trucks Developed on D. & H. Ry. Age, vol. 73, no. 4, July 22, 1922, pp. 145–147, 6 figs. Utilization of excess boiler capacity and weight of tender as sources of revenue tractive power.

British. Great Northern Railway—Pacific Type Passenger Engine. Engineer, vol. 133, no. 3459, Apr. 14, 1922, pp. 412–413, 5 figs. partly on p. 416. Dimensions and ratios of most powerful express engine in Great Britain. Engine is 3-cylinder type; connecting rods and couplings are of nickel-chrome steel.

Electric. See ELECTRIC LOCOMOTIVES

Fireboxes. Locomotive Fireboxes. Ry. Gaz., vol. 37, no. 5, Aug. 4, 1922, p. 154. Method of protecting parts in contact with extreme heat and flame from damaging effects of oxidation.

Fireless. Fireless Locomotives. Times Trade & Eng. Supp., vol. 10, no. 215, Aug. 19, 1922, p. 465, 2 figs. Osmotic storage of energy. Refers to apparatus invented by Honigmann about 40 years ago, and recent improvement in arrangement proposed by Dr. Schreber. Boilers described might be used in passenger steamers over short distances or for driving of single cars on railway lines with light traffic.

4–8–0. Three-Cylinder Locomotive for Spanish Service. Ry. Mech. Engr., vol. 96, no. 8, Aug. 1922, pp. 445–449, 6 figs. 4–8–0 type, weighing 194,000 lb.; weight of tender, 112,500 lb. Sample locomotive built by Yorkshire Engine Co., Sheffield, England.

Garratt. A Garratt Locomotive Development. Ry. Gaz., vol. 37, no. 4, July 28, 1922, pp. 126–127. Describes 2–6–6–2 type engine constructed for S. African Railways; weight 133.75 tons; tractive effort 50,000 lb.

Gasoline Switching. Gasoline Switching Locomotive with Hydraulic Drive. Ry. Age, vol. 73, no. 8, Aug. 19, 1922, pp. 323–326, 7 figs. Universal oil transmission governs speed and direction and gives remarkable flexibility of control.

Internal-Combustion. A French Petrol Locomotive. Engineer, vol. 133, no. 3461, Apr. 28, 1922, p. 476, 2 figs. Details of Renault 19-ton gasoline locomotive. Translated from Génie Civil.

Meter-Gage. Meter Gauge Passenger Locomotives, Bombay, Baroda & Central India Railway. Ry. Gaz., vol. 37, no. 4, July 28, 1922, pp. 124–125, 5 figs. Describes engines which have recently been rebuilt; details of tenders which are fitted with patented differential bearing spring gear.

Mikado. Michigan Central Mikado Has Many Special Features. Ry. Age, vol. 73, no. 10, Sept. 2, 1922, pp. 411–415, 5 figs. Describes 2–8–2-type locomotive for freight service designed to provide maximum hauling capacity with minimum fuel consumption without exceeding allowable limit of weight; tractive effort without booster, 63–500 lb.

Palestine Railway. New Locomotives and Rolling-Stock for the Palestine Railway. Ry. Gaz., vol. 37, no. 6, Aug. 11, 1922, pp. 194–196, 7 figs. partly on p. 197. Built in England to special designs and specifications; describes 2–8–4-type heavy tank-engine locomotives, and first- and second-class passenger cars.

Rod Testing. How Locomotive Rods are Tested and Machined at Lima. Ry. Rev., vol. 71, no. 8, Aug. 19, 1922, pp. 231–234, 6 figs. New testing machine eliminates defective rods and use of special jigs insures uniform dimensions.

Stability at High Speeds. Stability of Locomotives at High Speeds. Ry. Engr., vol. 43, no. 511, Aug. 1922, pp. 302–313, 13 figs. Experiments carried out on London, Brighton & South Coast Ry. with five different types of engines to determine relative actions of varying bogie control systems and locomotive wheel arrangements while hauling heavily loaded express trains on main line.

Steam-Turbine. Turbine Locomotives (La locomotive à turbines), J. Netter. Nature, no. 2514, June 10, 1922, pp. 365–367, 4 figs. Describes type manufactured in 1914 in Milan, and another type made by Escher Wiss & Co., Zurich, Switzerland, with special tender for necessary cooling apparatus for condenser.

The Ljungström Turbine Locomotive. Engineering, vol. 114, nos. 2951, 2953, 2954 and 2955, July 21, Aug. 4, 11 and 18, 1922, pp. 64–70, 26 figs.; 131–133, 29 figs. partly on supp. plate; 163–168, 27 figs. and 198–203, 19 figs. Motive power is condensing steam turbine developing 1800 hp. which drives 3 pairs of coupled wheels by means of double-reduction gearing. Forced lubrication to all working parts.

Switching. Petrol Shunting Locomotive at Kelso, North British Railway. Ry. Gaz., vol. 37, no. 1, July 7, 1922, p. 17, 3 figs. Description of four-wheeled locomotive with 40 b.hp. engine with roller chains to axle.

Tank. New Express Passenger Tank Locomotives, Glasgow & South Western Railway. Ry. Engr., vol. 43, no. 511, Aug. 1922, pp. 298–301, 6 figs. Characteristics of 4–6–4 type locomotive: Cylinders, 22-in. diam. by 26-in. stroke; coupled wheels, 6 ft. diam.; total heating surface, 1985 sq. ft.; coal capacity, 3½ tons. Account of trial run.

New 4–6–4 Type Tank Engines for Java. Ry. Gaz., vol. 37, no. 1, July 7, 1922, p. 18–19, 5 figs. Steam distribution to cylinders by means of inside admission piston valves.

Works. The Locomotive Works of Sir W. G. Armstrong Whitworth & Co., Ltd. Eng. Production, vol. 5, nos. 93 and 94, July 13 and 20, 1922, pp. 31–36 and 61–65, 21 figs. Description of plant and working methods.

LUBRICATING OILS

Storing and Clarifying. Storing and Clarifying Oil in Shops. Am. Mach., vol. 57, no. 4, July 27, 1922, pp. 125–127. Methods used in 12 well-known plants. Tanks, separators, mixtures and other details.

Wax Extraction. Wax Extraction by Centrifugal Force. Oil & Gas Jl., vol. 21, no. 7, July 13, 1922, pp. 14 and 92–93, 3 figs. Separating wax crystals from lubricating oils; latest developments by Maryland Refining Co.

LUBRICATION

Tests. Lubrication Tests, H. T. Newbigin. Engineering, vol. 114, no. 2957, Sept. 1, 1922, pp. 260–261, 7 figs. Describes tests made with segmental, pivoted blocks or pads, of Michell type, running against a plane surface thereby providing mechanical conditions necessary for formation of true pressure oil films.

M

MACHINE-TOOL INDUSTRY

Sweden. The Machine Tool Industry in Sweden Machy. (N. Y.), vol. 29, no. 1, Sept. 1922, pp. 31–32. Notes on leading machine-tool building plants and their products.

MACHINE TOOLS

Design and Manufacture. Machine Tools; Their Design and Manufacture, Joseph Horner. Engineering, vol. 114, no. 2956, Aug. 25, 1922, pp. 231–233. Notes on increased complication of machine tools; changing aspects of tooling; problem of increased output; automatic movements; materials; manufacture; jigs; tolerances, interchangeability; shop drawings; etc.

MALLEABLE CASTINGS

Manufacture. Making Malleable Castings, Enrique Touceda. Foundry, vol. 50, nos. 14, 15 and 16, July 15, Aug. 1 and 15, 1922, pp. 583–593, 622–626 and 676–680, 16 figs. July 15: Suggestions covering principles governing layout of American malleable foundry; how air furnaces are designed; suggestions for bungs and grates. Aug. 1: Metallurgical problems encountered in melting; finishing castings. Aug. 15: Tests showing effect of size of grates in distribution of metal; causes of picture-frame structure. (Abstract.) Paper read before Inst. Brit. Foundrymen.

MALLEABLE IRON

Advantages. Malleable Cast Iron, Enrique Touceda. Am. Mach., vol. 57, no. 9, Aug. 31, 1922, pp. 321–325, 7 figs. Poor qualities of pure cast iron; factors that make malleable cast iron superior; soundness, strength and good machineability attained.

METAL SPRAYING

Schoop Process. Protective Coatings of Sprayed Metal, Robert G. Skerrett. Iron Age, vol. 110, no. 5, Aug. 3, 1922, pp. 286–287, 2 figs. Late developments with Schoop process abroad; examples of applications and operating features; spraying pistol operated electrically. Article, based on European information, does not refer to developments of Schoop process in United States.

METALLOGRAPHY

Etching Reagents. Metallographic Etching Reagents: for Copper Alloys, Nickel, and the Alpha Alloys of Nickel, Henry S. Rawdon and Marjorie G. Lorentz. U. S. Bur. of Standards Sci. Papers, vol. 17, no. 435, Apr. 27, 1922, pp. 635–676, 27 figs. Gives experimental results to show importance of films varying in thickness upon different crystals in a metallographic specimen in producing a "contrast etch pattern."

Institute, Sweden. The Metallographical Institute (Metallografiska institutet), Carl Benedicks. Jernkontorets Annaler, vol. 106, no. 6, 1922, pp. 203–220, 7 figs. Description of institute, its buildings, departments and equipment; review of its work.

Microscopic, Macrography and. Recent Progress in Microscopic Metallography and Macrography (Les récents progrès de la métallographie microscopique et de la macrographie), Léon Guillet. Révue Universelle des Mines, vol. 14, no. 1, July 1, 1922, pp. 1–17 (Metallurgical Section). Methods of microscopic metallography and macrography; examination and preparation of photographs; requirements of apparatus; results obtained.

METALS

Acid-Resisting. Acid-Resisting Metals and Alloys, George A. Drysdale. Mech. Eng., vol. 44, no. 9, Sept. 1922, pp. 579–580 and 621. Account of research work carried out on various non-ferrous metals and alloys, with especial reference to their use in manufacture of mine pumps and chemical apparatus.

Fatigue of. Fatigue or Progressive Failure of Metals under Repeated Stress, H. F. Moore, J. B. Kommers, and T. M. Jasper. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 23 pp., 21 figs. Discusses testing practice used in making repeated-stress tests, with especial reference to testing machines, test specimens and methods used in joint investigation of fatigue of metals now in progress. Recent test results are presented.

Fatigue of Metals, C. E. Stromeyer. S. Wales Inst. Engrs. Proc., vol. 38, no. 3, July 20, 1922, pp. 285–308 and (discussion) pp. 308–331, 2 figs. Description of fatigue-testing machine and results of tests.

Heat-Temperature Curves. Heat-Temperature Curves of Metals, Joseph F. Shagden. Iron Age, vol. 110, no. 4, July 27, 1922, pp. 218–222, 5 figs. Basis for average and instantaneous specific heat values provided by German laboratory tests. New specific heats for molten metal.

Properties. Deformation and Rupture of Solids (Déformation et rupture des solides), Mesnager. Révue de Métallurgie, vol. 19, nos. 6 and 7, June and July 1922, pp. 365–378 and 425–436, 37 figs. June: Elastic limit of mild steel and copper and experiments made in this connection. July: Rupture of fragile solids; difference between permanent deformation and rupture; experiments made by Dr. Karman at Göttingen on resistance of materials.

Tearing Tests. Tearing Tests on Metals, Henry L. Heathecote and C. G. Whinfrey. Chem. & Met. Eng., vol. 27, no. 7, Aug. 16, 1922, pp. 310–311, 2 figs. Methods and results of testing metals for resistance to tearing.

Tensile Strength. Tensile Strength of Plastic Metals, Friedrich Koerber. Mech. Eng., vol. 44, no. 6, June 1922, pp. 392–393, 2 figs. Presents method for computing tensile strength of metals from curve of "true" stresses; discusses mechanism of tensile rupture test and proposes theory of tensile stresses based on assumption of slip and torsion effects of crystalline elements in metal. Translated from Stahl u. Eisen, vol. 42, no. 10, Mar. 9, 1922, pp. 365–370.

X-Ray Investigation. X-Ray Investigations on Metals, R. Glockner. Iron & Coal Trades Rev., vol. 105, no. 2841, Aug. 11, 1922, p. 186, 2 figs. Suggestions based on writer's own work and work by other investigators. Translated from Stahl u. Eisen.

MILLING CUTTERS

Helical. Construction of Milling Cutters. Practical Engr., vol. 66, no. 1846, July 13, 1922, p. 19, 1 fig. Describes Kendal & Gent cutter, a steel forging in which plain helical grooves are milled; blades are bent in special machine.

MOLDING METHODS

Ingot Molds. Molding and Casting of Ingot Molds (Formen und Giessen von Blockformen), Carl Irresberger. Stahl u. Eisen, vol. 42, nos. 17 and 26, Apr. 27, and June 29, 1922, pp. 649–654 and 1013–1016, 29 figs. Apr. 27: Describes Kunze method adopted some 12 years ago which has been very successful. June 29: Process of Penn Mold and Mfg. Co., Dover, O.

MONEL METAL

Manipulation and Use. Monel Metal, S. E. Briggs. West. Machy. World, vol. 13, no. 8, Aug. 1922, pp. 276–277 and 282, 5 figs. Physical properties; directions for manipulation and use.

MOTOR BUSES

Trailer. Single Deck Trailer Bus Carries 65 People. Commercial Vehicle, vol. 26, no. 12, July 15, 1922, p. 28, 1 fig. Six-wheel design of Fruehauf Trailer Co. with air-operated doors and brakes.

MOTOR PLOWS

German. Germans Develop New Motor Plow Designs. Automotive Industries, vol. 47, no. 11, Sept. 14, 1922, pp. 524–527, 5 figs. Describes types shown at exhibition held by German Agricultural Soc.; 17 motor plow exhibits.

MOTOR TRUCKS

Chassis, Swiss. The 5-Ton Saurer Chassis. Automobile Engr., vol. 12, no. 166, Aug. 1922, pp. 226–236, 21 figs. Details of 5-ton lorry built by Saurer Co., St. Georgen, Switzerland.

Chassis Tests. Chassis Efficiency Tests, O. D. North. Automobile Engr., vol. 12, no. 166, Aug. 1922, pp. 237–242, 8 figs. Consideration of Riedler's investigation of a Bussing chain-driven truck.

Lacre. The New 4-Ton Lacre. Motor Transport, vol. 35, no. 910, Aug. 7, 1922, pp. 166–167, 5 figs. Details of chassis with spur-gear final drive, and 38.45-hp. 4-cycle engine.

Producer-Gas-Driven. The Thornycroft Suction Gas Vehicle. Motor Transport, vol. 35, no. 912, Aug. 21, 1922, pp. 235–237, 2 figs. Description of successful machine that won first prize in French producer-gas trials.

Wheels. A New Process of Manufacturing Truck Wheels. Automotive Industries, vol. 47, no. 6, Aug. 10, 1922, pp. 270–273, 23 figs. Describes equipment for rapid production of wheel from rolled steel I-beam, developed by Bethlehem Steel Co.; method involves series of cold punching and forming operations.

MOTOR TRUCKS, MILITARY

British War Office Specification. The New War Chassis. Motor Transport, vol. 35, no. 909, July 31, 1922, pp. 150–152. Specification of 30-cwt. pneumatic-tired lorry drawn up by British War Office M. T. Advisory Board: 24-hp. 4-cylinder engine; pump cooling; H. T. magneto; engine-driven tire pump; detachable wheels with detachable rims; chassis weight max. 29 cwt.; total weight 39 cwt.; speed 30 m.p.h.

MOTORCYCLES

British. The Raleigh Motor Bicycle. Engineering, vol. 114, no. 2957, Sept. 1, 1922, pp. 264–266, 11 figs. Engine is of 4-stroke type with mechanically operated valves.

German Types. German Motorcycles and Motorcycle Engines (Deutsche Motorräder und Kraftradmotoren), H. Maigel. Motorwagen, vol. 24, nos. 33 and 34, Nov. 30 and Dec. 10, 1921, pp. 727–730 and 751–755 and vol. 25, no. 7, Mar. 10, 1922, pp. 133–137, 35 figs. With special reference to types exhibited at German 1921 automobile show.

N

NATURAL GAS

Gasoline from. The Absorption of Gasoline from Natural Gas, R. C. Cantelo. Can. Chem. & Metallurgy, vol. 6, nos. 8 and Aug. and Sept. 1922, pp. 177–179 and 196–200, 1 fig. Aug.: Methods of testing natural gas from gasoline content. Theory and development of absorption process. Sept.: Calculating amount of absorbent necessary for complete removal of gasoline from gas. Results of experiments.

NICKEL ALLOYS

Nickel-Chromium. Exhaust Valves of Nickel-Chromium Alloy. Motorship, vol. 7, no. 9, Sept. 1922, p. 679, 4 figs. Describes nichrome, an alloy produced by Driver, Harris Co., Harrison, N. J., said to be practically immune to pitting, warping and other destructive forces.

Properties. Some Nickel Alloys. Metal Industry (Lond.), vol. 21, nos. 4 and 6, July 28 and Aug. 11, 1922, pp. 78–82 and 129–130, 5 figs. Properties and chief features of more important ferrous and non-ferrous nickel alloys.

NICKEL-CHROME STEEL

Manufacture. The Making, Forging and Heat Treating of Nickel Chromium Steels, Harry Brearley. Forging & Heat Treating, vol. 8, no. 8, Aug. 1922, pp. 341–345, 2 figs. Characteristics and nature of nickel-chromium steels; causes of failure and remedy therefor; comparison of nickel and nickel-chromium steels. Lecture before Assn. Drop Forgers & Stampers.

NOMENCLATURE

A.S.T.M. Committee Report. Report of Committee E-8 on Nomenclature and Definitions. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 11 pp. Report on tentative definitions.

NON-FERROUS METALS

A.S.T.M. Committee Report. Report of Committee B-2 on Non-Ferrous Metals and Alloys. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 23 pp., 2 figs. Includes notes on physical properties of A.S.T.M. tentative standard white-metal bearing alloys, by John R. Freeman, Jr. Proposed tentative specifications for copper pipe, brass pipe, and seamless admiralty condenser tubes and ferrule stock.

Gas Absorption and Oxidation. Gas Absorption and Oxidation of Non-Ferrous Metals, B. Woyski and John W. Boeck. Metal Industry (N. Y.), vol. 20, nos. 7 and 8, July and Aug. 1922, pp. 267–268 and 307–308, 2 figs. Discussion of furnace atmospheres and their relation to condition of metal.

O

OIL

World Supply. The Oil Supply of the World, David White. Mech. Eng., vol. 44, no. 9, Sept. 1922, pp. 567–569. Estimates of oil resources of various regions of earth. Economic future as to oil in United States. Measures necessary to be taken in order to increase and conserve domestic supply. (Abridgment.)

OIL ENGINES

Brotherhood. Brotherhood Oil Engines for Crude and Residual Fuels. Oil Eng. & Finance, vol. 1, no. 25, July 1, 1922, pp. 837–840, 6 figs. Description of Brotherhood gas and oil engines.

Brotherhood-Still. The "Brotherhood-Still" Oil

Engine. Oil Eng. & Finance, vol. 1, no. 24, June 24, 1922, pp. 777–778, 1 fig. Compound steam and internal-combustion engine containing double-action piston with usual air exhaust and admission valves showing phenomenal fuel consumption.

Fullagar Land-Type. The Fullagar Oil Engine for Land Purposes. Engineer, vol. 133, no. 3461, Apr. 28, 1922, pp. 466–468, 7 figs. partly on p. 470. Describes land-type engine built on Fullagar system, which is said to have all advantages of marine type, chief among them being excellent balancing of reciprocating parts. See also English Elec. Jl., vol. 2, no. 2, Apr.-July, pp. 61–67, 8 figs.

Marine. Developments in the Design of Marine Oil Engines. Mar. Engr. & Naval Architect, vol. 45, nos. 534, 535, 537 and 539, Mar., Apr., June and Aug., 1922, pp. 124–126, 147–149, 225–228 and 305–308, 38 figs. Mar.: Different types Burmeister & Wain, Vickers, North British Diesel, Tosi, Werkspoor, Doxford, and Camellaird-Fullagar. Apr.: Built, solid, and partly built crankshafts; trend of column and framing design; two and four-stroke pistons and cylinder covers; piston clearances and methods of cooling; June: Construction of reciprocating parts; starting and inlet valve arrangements; high-pressure solid-injection fuel pumps; air compressors. Aug.: Valve operating mechanism; material and design of cams; valve setting diagrams; methods of reversing.

OIL FUEL

Burners. Navy Testing Plant Perfects Oil Burner, Charles E. Kern. Oil & Gas Jl., vol. 21, no. 5, June 29, 1922, pp. 11 and 100. Mechanical pressure of oil atomizes it giving rapid whirling motion inside burner which causes expansion into cone that disintegrates into fine oil mist.

Distribution in Industrial Plants. Distribution of Fuel Oil in Industrial Plants, J. A. Brown. Forging & Heat Treating, vol. 8, no. 8, Aug. 1922, pp. 336–340, 4 figs. Character of fuel oil defined in terms of temperature, gravity and viscosity; effect of pipe size, velocity and viscosity on friction head; analysis of cost service.

OPEN-HEARTH FURNACES

Progress. Progress in the Open-Hearth Process, Willis McKee. Iron Age, vol. 110, no. 3, July 20, 1922, pp. 147–149, 2 figs. Results from blow-torch furnace; its principles and advantages. Steel-encased regenerators. (Abstract.) Paper read before Am. Foundrymen's Assn.

Talbot Process. The Talbot Process Compared with other Processes. Iron & Coal Trades Rev., vol. 105, no. 2840, Aug. 4, 1922, p. 146. Conclusions regarding advantages of Talbot process over other open-hearth steel-making processes. Translated from Stahl u. Eisen.

OXY-ACETYLENE CUTTING

Production Costs. Oxygen for Cutting Purposes. Eng. Production, vol. 5, no. 98, Aug. 17, 1922, p. 152. Comparative data on production costs.

OXY-ACETYLENE WELDING

Ingot-Iron Composition. Composition of Ingot Iron for Effective Autogenous Welding (Beschaffenheit des Flusseisens für gute Schmelzflammen-Schweissung), C. Diegel. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 246, 1922, 44 pp., 146 figs. on supp. plates. Experiments to determine effect of 0.27 per cent Si and 0.25 per cent Ni, which show that Si is injurious while Ni is not.

P

PACKINGS

Labyrinth. Steam Loss in Labyrinth Packings (Dampfverlust in Labyringthdichtungen), A. Winkhaus. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 33–34, Aug. 26, 1922, pp. 804–807, 9 figs. Determination of discharge and its application to calculation of a labyrinth.

PAINTS

Accelerated Weathering. Accelerated Weathering of Paints on Wood and Metal Surfaces, Harley A. Nelson. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 15 pp., 6 figs. Describes effort to reproduce directly on typical surfaces, not only changes in some one physical property, but all of more common paint failures observed on painted wood and metal structures.

Black Pigments. The Manufacture and Use of Black Pigments, H. L. Blachford. Can. Chem. & Metallurgy, vol. 6, nos. 7 and 8, July and Aug. 1922, pp. 156–158 and 180–181. Definition, manufacture and uses of carbon, lamp, bone, charcoal and various other blacks.

Specifications. Report of Committee D-1 on Preservative Coatings for Structural Materials. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 60 pp., 1 fig. Proposed revised tentative definitions of terms relating to paint specifications; specifications for raw or refined soya bean and perilla oil and raw tung oil; methods of analysis of yellow and orange pigments, blue pigments and chrome green; report on varnish; specifications for carbon black, lampblack, bone black, chrome yellow and chrome green.

Physical Properties. Some Physical Properties of Paints, P. H. Walker and J. G. Thompson. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 19 pp., 6 figs. Results of investigations on plastometer measurements, preparation of paint films, effect of varying composition on paint films, thinning power of turpentine, and aging of basic carbonate white lead paints before application.

PAPER MANUFACTURE

Beating. Is Beating Really Understood? Paper, vol. 30, no. 21, July 29, 1922, pp. 7–10. Preparation of pulps for bond and ledger papers made principally from rag fiber.

Improvements. Recent Advances in Pulp and Paper, Clarence J. West. Jl. Indus. & Eng. Chem., vol. 14, no. 9, Sept. 1922, pp. 858–860. Deals with raw materials; improvements in processes; analytical methods; beating, bleaching, and sizing.

Lime in Pulp Manufacture. Uses of Lime in Pulp Manufacture, George K. Spence. Paper, vol. 30, no. 19, July 12, 1922, pp. 7–9. Old and new methods of causticizing soda with lime in soda and sulphate processes.

Strawboard Wastes. The Treatment and Disposal of Strawboard Wastes, H. B. Hommon. Am. Soc. Civ. Engrs. Proc., vol. 48, no. 6, Aug. 1922, pp. 1397–1402. Complete account of studies made at American Strawboard Mill, Noblesville, Ind., for developing methods to treat wastes resulting from manufacture of paper from straw.

PAPER MILLS

Electric Drive. Sectional Paper Machine Drive, Stephen A. Staege. Paper, vol. 30, nos. 17 and 18, June 28 and July 5, 1922, pp. 9–11 and 17. Electrical way of individual motors has simplified equipment and proved best.

Steam Utilization. Steam Utilization in a Modern Newsprint Mill, S. W. Slater and J. E. A. Warner, Mech. Eng., vol. 44, no. 9, Sept. 1922, pp. 587–592, 6 figs. Analysis of conditions obtaining in modern paper mill manufacturing newsprint, dealing with selection of prime mover, electric vs. rope drive for paper machines, drying of paper, ventilation requirements, etc. (Abridgment.)

Wastes. Wastes from Pulp and Paper Mills Chemically Considered, H. W. Clark. Am. Soc. Civ. Engrs. Proc., vol. 48, no. 6, Aug. 1922, pp. 1393–1396. Writer states it is often possible to remove 70 per cent or more of primary polluting matters of paper-mill wastes. Apparently only wastes recovered with profit as yet are those from soda-pulp process and wastes from paper machine.

PIPE, STEEL

Bending Large. Bending Large Pipe, Charles O. Herb. Machy. (N. Y.), vol. 29, no. 1, Sept. 1922, pp. 1–7, 8 figs. Procedure in hand-bending large-sized wrought-iron and steel pipe while hot and packed with sand.

PIPE, WROUGHT IRON

Heat Losses. Heat Losses from Bare and Covered W. I. Pipe at Temperatures up to 800 Deg. Fahr., R. H. Heilman. Mech. Eng., vol. 44, no. 7, July 1922, pp. 435–437, 3 figs. Presents findings of experimental investigation conducted in Mellon Inst. of Indus. Research of University of Pittsburgh. Empirical formulas are presented whereby loss from insulated pipes of any diameter may be readily calculated. (Abridgment.)

PISTON RINGS

Design. Piston-Rings and Ring Grooves, C. R. Manes. Soc. Automotive Engrs. Jl., vol. 11, no. 3, Sept. 1922, pp. 262–264 and (discussion) 228–231, 1 fig. Defines purpose of piston ring for internal-combustion engine and discusses gas and oil leakage, disputing H. H. Platt's views on these two points in recent paper. Advantage of multiple-piece rings over one-piece type. Table giving width and depth for piston-ring grooves.

Engineering and Manufacturing Practice. Piston-Rings, John Magee. Soc. Automotive Engrs Jl., vol., 11, no. 3, Sept. 1922, pp. 273–274 and (discussion) 228–231. Comments with view to standardization of best engineering and manufacturing practice. States that cast iron is only satisfactory metal suitable for use in internal-combustion engines. Discusses leakage and oil-pumping, width and form, and manufacturing difficulties.

Oil-Scraper, Test of. Test of Oil Scraper Piston Ring and Piston Fitted with Oil Drain Holes, H. S. McDewell. Nat. Advisory Committee for Aeronautics Tech. Notes, nos. 88 and 114, Aug. and Sept. 1922, 12 pp., 2 figs. and 8 pp. Tests to determine whether or not properly located and designed oil-scraper piston ring, installed on piston provided with oil drain holes of sufficient area, would prevent excessive oiling of Liberty engine.

PISTONS

Aluminum. Aluminum Pistons, Ferdinand Jehle and Frank Jardine. Soc. Automotive Engrs. Jl., vol. 11, no. 3, Sept. 1922, pp. 225–228 and (discussion) 228–231, 8 figs. Discusses thermal properties, such as actual operating temperature, temperature distribution, and effect of cooling-water temperature and piston material on piston temperature

The Aluminum-Alloy Piston, James E. Diamond Soc. Automotive Engrs. Jl., vol. 11, no. 3, Sept. 1922, pp. 258–261 and (discussion) 228–231, 1 fig. Discusses piston and cylinder relations; aluminum alloys suitable for pistons; outlines progress of design; ring-groove wear; gives tabular data and chart relative to heat treatment.

Light-Metal Alloys for. Light Metal Alloys for Pistons, Wallace Dent Williams. Raw Material, vol. 5, no. 7, Aug. 1922, pp. 259–266, 24 figs. Cast aluminum alloy pistons; cast and drawn magnesium alloy pistons. Special contrivances used in tests to investigate operating values of various light-metal pistons; influence of crust of soot

PITOT TUBES

Wind Velocity, Measurement of. On the Use of Very Small Pitot-Tubes for Measuring Wind Velocity, Muriel Barker. Royal Soc. Proc., vol. 101, no. A712, Aug. 1, 1922, pp. 435–445, 5 figs. Account of experiments and results.

PLANERS

Controller, Electric. Electric Control of Planer Table Movement. Can. Machy., vol. 28, no. 7, Aug. 17, 1922, pp. 21 and 39, 2 figs. Describes Cutler-Hammer full-magnetic planer controller, and its operation.

PNEUMATIC TOOLS

Machining and Assembling. Machining and Assembling Operations on Pneumatic Tools, Howard Campbell. Am. Mach., vol. 57, nos. 2, 3, 4 and 5, July 13, 20, 27 and Aug. 3, 1922, pp. 49–51, 101–104, 134–136 and 175–177, 42 figs. July 13: Drilling air-hammer parts; boring, reaming, grinding and lapping piston holes. July 20: Turning and drilling crankshafts for air motors; machining valves. July 27: Milling and grinding operations on connecting rods for air motors; swaging and milling. Aug. 3: Boring and reaming air-motor cylinders; setting valves; testing brake.

POWER GENERATION

Prime-Movers Statistics. Prime Movers in Central Stations Total 19,737,361-Hp. Elec. World, vol. 80, no. 4, July 22, 1922, p. 169. Analysis of development of electric light and power companies indicates total of 13,331,933 hp. in steam motors, of which 87 per cent is for steam turbines; boiler installation totals 4,042,922 hp.

POWER PLANTS

Design. Developments in Power Station Design. Engineer, vol. 133, nos. 3459, 3461, 3463, 3464, 3465, 3466 and 3467, Apr. 14, 28, May 12, 19, 26, June 2 and 9, 1922, pp. 406–409, 8 figs.; 457–459, 7 figs.; 529–532, 12 figs.; 545–547, 11 figs.; 574–578, 14 figs.; 608–610, 13 figs.; and 631–634, 14 figs. Apr. 14: Parsons 10,500-kw. turbo-generator at Carville station. Apr. 28: Hickson-Hargreaves surface condensing plant, ejectair, and jet condenser. May 12: Mirlees-Watson condensing plant built for Bankside station of London Elec. Light Co.; jet condensers with Delas air extractors. May 19: Flow of fluids in pipes; electrical flow meters. May 26: Circular-type condensers of English Elec. Co.; Willan's condensing plant at Dalmarnock. June 2: Air filters for power-house use; water-cooled rotors; design of switchgear. June 9: Transformers; current-limiting reactances; rectifiers.

Economies. Power Plant Economies, George E. Wood. Coal Industry, vol. 5, no. 6, June 1922, pp. 267–270, 5 figs. Practical value of accurate boiler room records; evil results of scale accumulation; losses from soot as high as $15,000 per year; uncovering of air leaks and bad pipe connections.

Jenckes Spinning Co., Pawtucket. The Tamarack Power Plant. Power Plant Eng., vol. 26, no. 17, Sept. 1, 1922, pp. 837–843, 14 figs. Plant supplying power to largest procedures of tire fabric in United States, designed by its operating engineer.

Oil Refining. Power for the Atlantic Refining Co. Power Plant Eng., vol. 26, no. 15, Aug. 1, 1922, pp. 739–746, 14 figs. Describes construction and methods of operation of one of 17 power plants ranging from 500 to 1000 hp. per unit.

POWER TRANSMISSION

Paper Mills. Power-Transmission Systems of Three Big Paper Mills, H. Hilman Smith, Jr. Belting, vol. 21, no. 2, Aug. 1922, pp. 21–25, 8 figs. Layouts in Haverhill, Piermont and Chicago divisions of Robert Gair Co. Rubber belts used chiefly.

PRODUCER GAS

Production and Use. Production of Producer Gas and Use in Open-Hearth Furnaces (Considérations sur la production et l'utilisation du gaz pauvre de gazogènes pour le chauffage des fours Martin), G. Husson. Révue de l'Industrie Minérale, no. 38, July 15, 1922, pp. 373–406, 3 figs. Technical value of a gas; theory of gasification of coke; influence of different kinds of coal; handling of different gas producers; etc.

PULLEYS

Automatically Lubricated. Pulleys with Automatic Lubrication, J. H. Blakey. Power Plant Eng., vol. 26, no. 15, Aug. 1, 1922, p. 759, 5 figs. Description of pulley of French origin with automatic lubrication for use especially in cranes which are difficult of access.

PULVERIZED COAL

Boiler Firing. Experiments With Pulverized Coal Firing (Versuche mit einer Kohlenstaubfeuerung), F. Kaiser. Zeit. des Bayerischen Revisions-Vereins, vol. 26, nos. 13, 14 and 15, July 15, 31 and Aug. 15, 1922, pp. 106–107, 115–117 and 122–124, 3 figs. Preparation, drying and conveying of coal; firing pulverized coal; effect of radiation.

Hazards. Pulverized Fuel and Its Hazards. Steam, vol. 30, no. 3, Sept. 1922, pp. 67–71. Advantages of pulverized fuel; considers types of systems, dryer, burner construction, crushing, drying and pulverizing with regard to explosion hazard.

PUMPING

Hot Liquids. The Pumping of Hot Liquids, Wm. Mason. Gas Jl., vol. 159, no. 3092, Aug. 16, 1922, pp. 374–375, 2 figs. Difficulties are explained and method of circumventing them set forth.

PUMPS, CENTRIFUGAL

Development and Operation. Centrifugal Pumps, H. Kilian. Fördertechnik u. Frachtverkehr, vol.

15, no. 16, Aug. 4, 1922, pp. 212-216, 7 figs. Notes on development, operation, delivery and suction head, efficiency, power consumption, regulations for erection, attendance, etc.

Dredging and Sand Pumping. Pumps Used in Dredging and for Pumping Sand, E. T. Keenan. Cement, Mill & Quarry, vol. 21, no. 4, Aug. 20, 1922, pp. 29-31, 3 figs. Design of pumps handling sand and rock.

Electrically Driven. Electrically Driven High Pressure Centrifugal Pump. Engineer, vol. 133, no. 3465, May 26, 1922, p. 591, 3 figs. partly on p. 584. Capable of delivery 800 gal. per min. at pressure of 1150 lb. per sq. in. Installed in pumping station, Manchester, England.

PYROMETERS

Radiation. The New Radiation Pyrometer "Pyro" (Das neue Strahlungs-Pyrometer "Pyro"). Zeit. fur die gesamte Giessereipraxis, vol. 43, no. 27, July 15, 1922, p. 377. Its advantages, simplicity of operation, and application to high and low temperatures.

Total Radiation. Total Radiation Pyrometer, Eberhard Zopf. Eng. Progress, vol. 3, no. 8, Aug. 1922, p. 180, 2 figs. Describes ardometer constructed by Siemens & Halske.

R

RAILS

Heat Treatment. The Improvement of Rails and Tyres by Means of Heat Treatment, James Waite. Commonwealth Engr., vol. 9, no. 12, July 1, 1922, pp. 435-438, 4 figs. Notes on Sandberg treatment.

Joints. Why Use Base Plates With Welded Rail Joints? Howard H. George. Elec. Ry. Jl., vol. 60, no. 8, Aug. 19, 1922, pp. 265-266. Base plates not needed if correct design of joint plate is worked out, additional weight of metal and increased amount of welding do not economically solve problem.

121-Lb.-Section. A New 121-Lb. "Market Street Rail" for San Francisco. Elec. Ry. Jl., vol. 60, no. 5, July 29, 1922, p. 163, 2 figs. Data on new rails to be laid in Market Street tracks, which are modification of present standard 9-in. girder rail.

Wear, Measurement of. Determination of Rail Wear for Valuation Purposes, J. P. Newell. Eng. News-Rec., vol. 89, no. 8, Aug. 24, 1922, pp. 310-312, 3 figs. Cross-sections accurately measured in field; rails rated by scientific analysis of observed deterioration. Describes rail pantograph invented by S. W. Fairweather.

RAILWAY ELECTRIFICATION

Argentine. Steam Road Electrifications in the Argentine, Lynn G. Riley. Ry. Age, vol. 73, no. 9, Aug. 26, 1922, pp. 375-378, 7 figs. Electrification of Buenos Aires & Western, its service conditions and locomotive equipment.

British. British Railways Electrification. Elec. Ry. & Tramway Jl., vol. 46, no. 1136, June 16, 1922, pp. 257-264, 5 figs. South Eastern and Chatham electrification. London Tube; Great Eastern; London and North-Western; London, Brighton and South-Coast; and Metropolitan railways.

Germany. Electric Traction on German State Railways (Die elektrische Zugförderung auf den deutschen Reichsbahnen), H. Gleichmann. Organ für die Fortschritte des Eisenbahnwesens, vol. 77, nos. 9, 10 and 11, May 1, 15 and June 1, 1922, pp. 127-132, 143-147 and 159-163, 47 figs. mainly on supp. plates. Notes on selection of current; the Bavarian system, a three-phase system of 100 kv.; Bavaria's available water power; the Walchen Lake hydroelectric plant; the Isar-River plants. Possibilities for development of electric traction in Germany.

London & North Western. Electrification of the London and North-Western Railway. Elec. Times, vol. 62, no. 1604, July 13, 1922, pp. 27-28, 2 figs. Data on electrification of suburban lines recently completed by conversion of line from Euston to Willesden. Description of rolling stock, power-generating stations and auxiliaries. Indicators with names of stations carried at each end of train.

RAILWAY MOTOR CARS

Diesel-Electric. Swedish Railways Increase Use of Diesel Electrics. Elec. Ry. Jl., vol. 60, no. 6, Aug. 5, 1922, pp. 193-195, 4 figs. Success of small motor cars leads to introduction of those with 160 and 250 hp. capacity; reduction in operating cost and improved service; performance data, dimensions and weights.

Gasoline. The Gasoline-Driven Motor-Coach for Railroad Service, Charles O. Guernsey. Soc. Automotive Engrs. Jl., vol. 11, no. 3, Sept. 1922, pp. 275-278 and (discussion) 278-280 and 283, 11 figs. Why so little progress has been made in developing railroad equipment operated by gasoline engines and what the field is for this class of equipment.

RAILWAY OPERATION

Freight Rates. Board of Railway Commissioners' Judgment and Order Reducing Freight Rates, etc. Can. Ry. & Mar. World, no. 294, Aug. 1922, pp. 395-400. Decision of Can. Board of Ry. Commissioners reducing freight rates.

Reclamation, Decentralized. De-Centralized Reclamation on the C. M. & St. P. Railway. Ry. Rev., vol. 71, no. 5, July 29, 1922, pp. 131-137, 8 figs. Policy of road to localize reclamation work wherever possible appears to possess certain advantages both from standpoint of reduced length of haul and wider coöperation enlisted. Account of organization of work and reclamation activities on road during past year.

Safety. "Safety in Railway Operation," J. W. Pringle. Inst. of Transport Jl., vol. 3, no. 5, July 1922, pp. 436-443 and (discussion) 443-450. Gives outline of fundamental principles governing safe conduct of traffic in respect of methods of operation, equipment, etc., and shows how accidents originate, with reference mainly to conditions and practice prevailing in England.

Suburban Passenger Service. The Operation of Heavy Suburban Passenger Services on a Steam Railway, With Particular Reference to Density of Service, Terminal and Other Facilities, F. V. Russell. Inst. of Transport Jl., vol. 3, no. 5, July 1922, pp. 451-475, 7 figs.

Time Tables. The Planning of Time Tables (Zur Lehre vom Fahrplan), J. Jahn. Glasers Annalen, vol. 91, no. 2, July 15, 1922, pp. 19-26, 10 figs. Formulas are developed for calculation of time tables based on ratios between varying speed of train and length of line.

Train Control. The Report of the Automatic Train Control Committee. Ry. Gaz., vol. 37, no. 7, Aug. 18, 1922, pp. 228-230. Conditions to be satisfied; essential requisites; anticipated cost and summary of recommendations.

Official Report on Train Control for British Railways. Ry. Rev., vol. 71, nos. 4 and 5, July 22 and 29, 1922, pp. 113-117 and 140-141. Report of Automatic Train Control Committee advising introduction of control at least at selected points.

Report of Automatic Train Control Committee. Ry. Engr., vol. 43, no. 510, July 1922, pp. 265-267. Committee recommends gradual adoption of automatic control, introduction of train-stops at stop-signals and warning-control at distant signals, and the formation of a committee of experts.

Wages and Working Conditions. Railway Wages and Working Conditions in Canada and the United States. Can. Ry. & Mar. World, no. 294, Aug. 1922, pp. 401-404. Comparison of situation in Canada and United States.

RAILWAY SHOPS

Electric Heat in. Use of Electric Heat in the Railway Shop, E. F. Collins. Ry. Rev., vol. 71, no. 3, July 15, 1922, pp. 69-72, 6 figs. Economy and wide range of usefulness for electric heating in railway shops not generally appreciated. Paper read before Assn. of Ry. Elec. Engrs.

Transfer Tables. Transfer Tables for Railway Shops (Schiebebühnen für Eisenbahnwerkstätten), H. Benedict. Fördertechnik u. Frachtverkehr, vol. 15, no. 16, Aug. 4, 1922, pp. 216-217, 4 figs. Discusses different types for locomotive works and railway shops; sunk and surface types.

RAILWAY SIGNALING

Automatic. The Re-Signaling of the Mersey Railway. Engineer, vol. 134, no 3471, July 7, 1922, pp. 16-18, 11 figs. Scheme carried out for automatic signaling between Liverpool, Central and Hamilton-Square stations, effect of which would allow number of block signals sections between stations named to be increased from two to four.

Power-Operated Facing Points. Long Distance Operation of Facing Points on Railways. Engineer, vol. 133, no. 3464, May 19, 1922, pp. 560-561, 5 figs. Describes power-operated facing points at Ashington Colliery.

St. Louis. Report on Improvement of Railroad Terminals in St. Louis. Ry. Rev., vol. 71, nos. 1 and 2, July 1 and 8, 1922, pp. 1-9 and 37-49, 17 figs. Engineers' Committee report to St. Louis Chamber of Commerce. July 1: Unification; bridges; rerouting East-Side passenger trains; improvements in Mill Creek Valley. July 8: Freight terminals and freight movements; time study; handling freight cars; proposed operation through outer group yards. See also Ry. Age, vol. 73, no. 2, July 8, 1922, pp. 63-68, 4 figs.

RAILWAY TIES

Creosoting Plant. A Sleeper Creosoting Plant. Engineer, vol. 133, no. 3463, May 12, 1922, p. 534, 4 figs. partly on p. 526. Describes creosoting plant built for Kenya, East Africa, comprising two large receptacles, of which lower one is working cylinder, together with necessary pumps and boiler. Capacity is 900 meter-gage sleepers per day of 8 hr.

Treated, Tests Results. Treated Tie Records on the C. B. & Q. R. R. Ry. Rev., vol. 71, no. 9, Aug. 26, 1922, pp. 272-274, 1 fig. Results of 12 years of tests, which show that ties treated with creosote are in best condition after 12 years' service and ties treated with mixture of zinc chloride and creosote are giving better service than those treated with zinc chloride alone.

RAILWAY TRACK

Track Bolts, Impact Loads on. Determining the Impact Loads on Track Bolts. Ry. Age, vol. 73, no. 7, Aug. 12, 1922, pp. 277-278, 4 figs. Tests performed on Philadelphia & Reading to evaluate and compare induced stresses.

RAILWAY YARDS

Moncton, Can. Improvements to Moncton Yard and Engine Facilities, S. B. Wass. Eng. Jl. (Eng. Inst. Can.), vol. 5, no. 9, Sept. 1922, pp. 445-450, 2 figs. Construction methods employed to minimize interference with traffic.

RAILWAYS

British Malaya. Railways in British Malaya Engineer, vol. 134, no. 3475, Aug. 4, 1922, pp. 114-116, 12 figs. partly on p. 118. Review of development.

Eastern Africa. Recent Railway Developments in Eastern Africa. Eng. News-Rec., vol. 89, no. 10, Sept. 7, 1922, pp. 400-401, 3 figs. Nile and lakes, linked with east coast. Labor gangs of 1000 natives on 200-mi. line. Zambesi railway opened.

Foreign Practice. Foreign Railway Practice, J. Carlier. Inst. of Transport Jl., vol. 3, no. 5, July 1922, pp. 426-433 and (discussion) 433-436, 1 fig. Remarks on electric traction; notes on some new forms of locomotives, including Heilmann, Ramsay, Zoelly, Société Cockerill, Pieper, Strang, Sulzer Freres, etc.; actual traction tendency.

REFRACTORIES

Fireclays. Manufacture on Fireclay Refractories, Alan G. Wikoff. Chem. & Met. Eng., vol. 27, no. 10, Sept. 6, 1922, pp. 505-509, 7 figs. Outline of plant operations at Evens & Howard Fire Brick Co., St. Louis; forming brick and special shapes, drying, burning.

Glass. A Critical Review of the Provisional Specifications for Glass Refractory Materials, W. J. Rees. Soc. of Glass Technology Jl., vol. 6, no. 22, Aug. 1922, pp. 181-193 and (discussion) pp. 193-204, 2 figs. Discusses specifications for silica bricks and cement, tank blocks, and pot clays.

Monolithic Furnace Lining. Refractory as a Factor of Furnace Life, I. S. Pieters. Power House, vol. 15, no. 15, Aug. 5, 1922, pp. 30-31. Modern tendencies said to be toward monolithic type of lining.

Thermal Conductivity. Report of Committee C-8 on Refractories. Am. Soc. for Testing Matls. advance paper for meeting June 26-30, 1922, 14 pp. Status of thermal conductivity in specifications for refractories.

REFRIGERATION

Compressors. Refrigeration for the Power Plant Engineer, T. H. Fenner. Power House, vol. 15, nos. 10, 11 and 12, May 20, June 5 and 20, 1922, pp. 19-22, 28-29, 31-32 and 34, 12 figs. May 20: Single and double-acting compressor, water jacketing, wet compression and oil sealing, oil separators, condensers and liquid receivers are described. June 5: Expansion valve and its function. June 20: Absorption process; aqua ammonia; parts and operating features of machine.

Two Suction Pressures. Refrigeration with Two Suction Pressures, H. J. Macintire. Power, vol. 56, no. 8, Aug. 22, pp. 279-281, 5 figs. Author attempts to show where there will be an advantage in compressing gas using two suction pressures in same cylinder.

REFRIGERATING MACHINES

CO_2 Compressor. The Carbonic Compressor, H. J. Macintire. Refrig. World, vol. 57, no. 7, July 1922, pp. 16-18, 3 figs. Advantages and disadvantages of CO_2 machines considered with diagram showing horsepower per ton of refrigeration for ammonia and carbon dioxide.

REFRIGERATING PLANTS

Ammonia Leaks, Locating. Locating Ammonia Leaks in Refrigerating Plants, A. J. Dixon. Southern Engr., vol. 38, no. 1, Sept. 1922, pp. 72-73, 1 fig. Practical pointers regarding simple methods of detecting ammonia leaks in piping, coils and condensers.

Precooler. Lettuce and Celery Pre-cooling Plant, Southern Engr., vol. 38, no. 1, Sept. 1922, pp. 60-63, 4 figs. Describes new system of precooling which reduces time of cooling before loading into refrigerator cars and also eliminates all re-icing of cars in transit.

RIVETING

Efficiency. Experiments to Determine the Changes Taking Place in Sheet Metal During Riveting (Versuche zur Ermittlung der in den Blechen beim Nieten bewirkten Formänderungen), R. Baumann. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 252, 1922, 66 pp., 132 figs. Effects of high pressure in riveting; cold, warm and hot riveting; deformations due to pressure of rivet head. Advises not to apply unnecessarily high pressure in riveting.

ROLLING MILLS

Electrically Driven. New Development in Rolling Mill Drive, A. K. Bushman. Blast Furnace & Steel Plant, vol. 10, no. 9, Sept. 1922, pp. 467-469, 3 figs. Describes new electric drive for hot strip mill of Trumbull Steel Co. at Warren, Ohio.

Plate Mills, Motor Drive for. Special Drive Designed for Plate Mill, F. D. Egan. Blast Furnace & Steel Plant, vol. 10, no. 9, Sept. 1922, pp. 461-463, 3 figs. Describes main motor drive for new 100-in. 3-high plate mill for Nat. Stamping & Enameling Co., rated 3,000 hp., 40 deg. cent., 2,200 volt, 3 phase, 60 cycle, 236 r.p.m.

Sheffield, England. The Hecla and East Hecla Works of Hadfields, Ltd., Sheffield, England. Iron & Coal Trades Rev., vol. 105, no. 2841, Aug. 11, 1922, pp. 179-182, 10 figs. partly on pp. 193-196. Details of steel foundry works including steel-making facilities, new rolling-mill shop and 28-in. mill; powerful boom-shearing plant, gas-producing plant and hydraulic water service. See also Engineer, vol. 134, no. 3476, Aug. 11, 1922, pp. 134-137, 14 figs. partly on supp. plate.

Sheet Mills. Boscarelli System of Sheet Rolling. Iron & Coal Trades Rev., vol. 105, no. 2842, Aug. 18, 1922, pp. 220-221, 10 figs. partly on p. 222. Advantages claimed are (1) saving in labor and fuel; (2) thickness of sheets more uniform, and thinner sheets can be rolled; and (3) increased production.

RUST PREVENTION

Parker Process. Parkerizing—A Rustproofing Process, L. C. Morrow. Am. Mach., vol. 57, no. 10, Sept.

7, 1922, pp. 361–364, 6 figs. Describes process and application. Kinds of parts treated. Apparatus and equipment required.

S

SCREW MACHINES

Automatic. Automatic Production of Parts, C. A. Handschin. West. Machy. World, vol. 13, no. 8, Aug. 1922, pp. 279–282, 4 figs. Notes on use of modern screw machines and design of cams for automatic duplication of special forms.

Economical Production on Automatics. Eng. Production, vol. 5, no. 99, Aug. 24, 1922, pp. 172–176, 22 figs. Principles underlying efficient tooling and caming of automatic screw machines. Examples of automatic production illustrating uses of standard Brown & Sharpe tools.

SCREW THREADS

Measurement. Work at the National Physical Laboratory—II. Machy. (Lond.), vol. 20, no. 514, Aug. 3, 1922, pp. 558–561, 7 figs. Internal effective diameter measurement of screw threads.

SCREWS

Standard. Report of the German Industry Committee on Standards (Normenausschuss der Deutschen Industrie). Maschinenbau, vol. 1, no. 7, July 8, 1922, pp. 473–492, 27 figs. Includes list of newly published and newly accepted standard sheets. Proposals for rivets, Whitworth and metric fine thread. Proposed tentative standards for screw holes and heads; testing workshop material. Alterations in standard sheets for hexagonal and cylindrical screws.

SEMI-STEEL

French Opinion of. A French Opinion of Semi-Steel. Foundry Trade Jl., vol. 26, no. 313, Aug. 17, 1922, pp. 128–129, 2 figs. Communication by E. Ronceray on J. Cameron's paper on semi-steel.

Metallurgy. The Metallurgy of Semi-Steel, David McLain. Foundry Trade Jl., vol. 26, no. 312, Aug. 10, 1922, pp. 110–114, 8 figs. Discusses potentialities, merits and development.

Production and Applicability. Melting Steel and Cast Iron together in the Cupola, J. Hogg. Foundry Trade Jl., vol. 26, no. 314, Aug. 24, 1922, pp. 160–162. Practical details based on author's experiences; applicability of semi-steel.

SHAFTS

Rotating. The Stability of Rotating Shafts (Zur Frage der Stabilität rotierender Wellen), Theodor Pöschl. Schweizerische Bauzeitung, vol. 80, no. 3, July 15, 1922, pp. 23–25, 2 figs. Simplification of the Lagrange equations. Investigation of flywheel excentrically keyed on to a thin shaft.

SPARK PLUGS

Knocking, Suppression of. Multiple Sparkplugs and the Suppression of Knocking, C. A. Norman. Automotive Industries, vol. 47, no. 7, Aug. 17, 1922, pp. 316–318, 3 figs. Experimental evidence intended to show how location of sparkplug and timing of spark affect tendency of engine to knock.

SPRINGS

Elliptic, Calculation of. The Calculation of Elliptic Springs, W. H. Armstrong. Ry. Mech. Engr., vol. 96, no. 8, Aug. 1922, pp. 438–440. Formulas and tables for rapid determination of capacity and deflexion.

Leaf. Modern Methods of Making Leaf Springs, E. F. Lake. Iron Age, vol. 109, nos. 19 and 20, May 11 and 18, 1922, pp. 1269–1274 and 1343–1346, 12 figs. May 11: Continuous process for automobile springs; preparing plates; automatic hardening; forming and quenching machines. May 18: Tempering furnaces; assembling, testing and inspecting.

STEAM

Flow in Pipes. Capacities of Steam Heating Mains as Affected by Critical Velocities of Steam and Condensate Mixtures, F. C. Houghten and L. Ebin. Am. Soc. Heat. & Vent. Engrs. Jl., vol. 28, no. 6, Sept. 1922, pp. 643–648 and (discussion), pp. 649–654, 4 figs. Report of coöperative work of this Society and U. S. Bur. of Mines Experiment Station, Pittsburgh.

The Critical Velocity of Steam in One-Pipe Systems, F. E. Giesecke. Am. Soc. Heat. & Vent. Engrs. Jl., vol. 28, no. 6, Sept. 1922, pp. 637–642, 5 figs. The term, one-pipe system, is used to designate steam-heating system in which steam flows in one direction and condensate in opposite direction through same pipe at same time. (Discussion), pp. 649–654.

Pressure-Reducing Valve. A Unique Reducing Valve, C. C. Brown. Power Plant Eng., vol. 26, no. 18, Sept. 15, 1922, pp. 912–913, 4 figs. Describes chronometer valve, a specially designed arrangement for reducing steam pressure, used successfully in large sugar refinery plant.

Properties at High Pressure. Properties of Steam at High Pressures, G. Eichelberg. Mech. Eng., vol. 44, no. 7, July 1922, pp. 447–449, 6 figs. Investigation into values of heat of vaporization of steam. Author attempts to establish relation between exponents in adiabatic equation, heat of vaporization, and specific heats of saturated steam by using this relation. Translated from Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 12, Mar. 25, 1922, pp. 275–277.

Raising, Electric. Steam Raising by Electricity. Elec. Rev., vol. 91, no. 2331, July 28, 1922, pp. 140–141, 2 figs. Economic and some mechanical features including description of 18,000-kw. 3-unit electric steam generator.

STEAM ACCUMULATORS

Electric Hot-Water and. Electric Heat-Storage Plants (Elektrische Wärmespeicheranlagen). Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 33–34, Aug. 26, 1922, pp. 793–796, 8 figs. Description of plants for storage of heat in form of hot water or steam. Calculation and economy of such accumulators. Information from Sulzer Bros., Winterthur, Switzerland.

Osmotic. From Honigmann's Soda Locomotive to Osmotic Storage of Energy (Von Honigmanns Natronlokomotive zum osmotischen Energiespeicher), K. Schreber. Wärme, vol. 45, no. 29, July 28, 1922, pp. 353–355. Comparison of described osmotic accumulator with a Ruth steam accumulator demonstrates economy of former. Osmotic accumulator for a textile mill.

See also LOCOMOTIVES, Fireless.

STEAM ENGINES

Exhaust Energy, Use of. Using Exhaust Energy in Reciprocating Engines, J. Stumpf and C. C. Trump. Mech. Eng., vol. 44, no. 6, June 1922, pp. 369–372, 15 figs. Theoretical problems are discussed and practical applications to either single-cylinder or multi-cylinder engines are suggested.

Heat Transformers. A New and a Long Life to the Steam Engine, Wm. P. Durtnall. Petroleum Times, vol. 7, no. 180, June 17, 1922, p. 857. Describes paragon heat-transformer which converts small volume of gases at 3,500 deg. to a larger volume in form of perhaps 200-lb. steam at temperature of 720 deg. Fahr. without use of ordinary boilers.

Pass-Out. Atlas One Cylinder Pass-Out Engine. Power House, vol. 15, no. 13, July 5, 1922, pp. 26–28, 9 figs. Engine developed for working economically in plants where large heating demand exists in comparison with power requirements, by Atlas Co., Copenhagen. See also Engineer, vol. 133, no. 3466, June 2, 1922, pp. 604–606, 10 figs.

Triple-Expansion, Compounding. The Compounding of a Triple Expansion Engine. Engineering, vol. 114, no. 2955, Aug. 18, 1922, pp. 203–206, 11 figs. Details of conversion work carried out on triple-expansion vertical Corliss engine.

Uniflow. Uniflow Steam Engines. Times Trade & Eng. Supp., vol. 10, no. 215, Aug. 19, 1922, p. 467, 1 fig. Application to railway locomotives.

The Efficiency of Unaflow Engines, A. D. Skinner Power, vol. 56, no. 9, Aug. 29, 1922, pp. 327–329, 1 fig. Points of engine design that determine results to be obtained from unaflow engines.

Valve Leakage. Experiments on Steam Engine Valve Leakage, J. E. Bycroft. Engineer, vol. 134, no. 3473, July 21, 1922, pp. 62–63, 5 figs. Results of experiments carried out by author in investigating leakage of steam past a piston drop valve 9-in. diam., designed to supply steam to central exhaust or uniflow engine.

STEAM PIPING

Testing Coverings. Efficiency of Steam-Pipe Coverings at High Temperatures. Engineering, vol. 114, no. 2953, Aug. 4, 1922, p. 155, 2 figs. Describes apparatus for determining efficiency of steam-pipe coverings designed by C. Jakeman of Nat. Physical Laboratory and constructed there.

STEAM POWER PLANTS

Condensate Disposal. Disposal of Condensate in Power Plants, Charles L. Hubbard. Nat. Engr., vol. 26, no. 9, Sept. 1922, pp. 398–402, 12 figs. Determination of method to be used; examples in use for varied services; operating details.

STEAM TURBINES

Belliss and Morcom. The Belliss and Morcom Steam Turbine. Engineering, vol. 113, nos. 2947 and 2948, June 23 and 30, 1922, pp. 773–776 and 803–805, 36 figs. partly on supp. plate. Review of reciprocating engines and turbines manufactured by this company. Producing turbines from 10 kw. to 10,000 kw. Destructive factors.

Blades, Machining. Machining Turbine Blades. Machy. (Lond.), vol. 20, no. 514, Aug. 3, 1922, pp. 537–543 and 547. Machines and methods employed in works of Wm. Beardmore & Co., Ltd., Dalmuir.

Calculation. The Graphic Calculation of Steam Turbines (Beitrag zur Berechnung der Dampfturbinen auf zeichnerischer Grundlage), Erich Henne. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 260, 1922, 58 pp., 22 figs. partly on supp. plate. Methods are derived for graphic calculation of reaction and impulse turbines.

High Pressure and Superheat. Possibilities of High Pressure and Superheat for Steam Turbines, J. A. Polson. Power Plant Eng., vol. 26, no. 18, Sept. 15, 1922, pp. 893–896, 3 figs. Theoretical discussion of problems from standpoints of constant heat content, constant temperature, and constant pressure.

Operation. Steam Turbine Operation, L. W. Heller. Assn. Iron & Steel Elec. Engrs., vol. 4, no. 9, Sept. 1922, pp. 673–699, 14 figs. Discusses methods used by the Duquwanw Light Co., Pittsburgh, in operation of steam-generating equipment on their system.

Trip Valves and Emergency Governors. Steam-Turbine Emergency Governors and Trip Valves, A. D. Palmer. Power, vol. 56, no. 9, Aug. 29, 1922, pp. 324–326, 8 figs. Different types are described.

STEEL

Alloy. See ALLOY STEELS.

Carbon. Treatment of Carbon Steels, Dean Harvey. Am. Mach., vol. 57, no. 10, Sept. 7, 1922, pp. 378–379. What various chemical compositions and treatments in steel making produce. Properties and uses of some steels. Methods of working.

Chromium. See CHROMIUM STEEL.

Cold-Drawn. Advantages and Limitations of Cold Drawn Steel in Automotive Work, Walter Rosenhain. Automotive Industries, vol. 47, no. 10, Sept. 7, 1922, pp. 469–472, 8 figs. Cold drawn work produces excellent finish and operations are simple and foolproof. Necessity for high ductility limits such work to softer grades of material. Notes on soft metals, effects on microstructure, bending, annealing, and alloy steels.

Gases in. Amount of Gases in Steel. Iron Age, vol. 110, no. 9, Aug. 31, 1922, p. 534. Results of some new German methods of analysis on basic Bessemer metal. Translated from article by Oberhoffer and Piwowarsky in Stahl u. Eisen, May 25, 1922.

High-Speed. See STEEL, HIGH-SPEED.

Nickel-Chrome. See NICKEL-CHROME STEEL.

Rate of Loading, Effect of. Effect of Rate of Loading on Tensile Properties of Boiler Plate, H. J. French. Chem. & Met. Eng., vol. 27, no. 7, Aug. 16, 1922, pp. 309–310. Effect of decrease in rate of loading on steel is different above and below blue heat, but little variation in tensile properties was observed when tests were performed 30 times as fast as ordinarily.

Rustless. Rustless Steels (Rostfreie Stähle), Karl Daevew. Stahl u. Eisen, vol. 42, no. 34, Aug. 24, 1922, pp. 1315–1320, 5 figs. Notes on composition, properties, method of treatment and uses.

Semi-Steel. See SEMI-STEEL.

Stainless. Stainless Steel at High Temperatures, H. J. French. Iron Age, vol. 110, no. 7, Aug. 17, 1922, pp. 404–405, 3 figs. Heat treatment which produces greatest strength for use in valves of internal-combustion engines. Published by permission of Bur. of Standards.

Tests. Tests with Mild Steel (Versuche mit Weicheisen), Richard Baumann. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 35, Sept. 2, 1922, pp. 825–826, 8 figs. Tensile and notched-bar tests at higher temperature (notched-bar tests also at low temperature) demonstrate that metal which is unusually soft or tough at usual temperature shows same behavior as ordinary mild steel at high and low temperatures. At temperatures above 200 deg. cent. a high degree of elongation takes place.

Thermal Expansion. Thermal Expansion of a Few Steels, Wilmer Souder and Peter Hidnert. U. S. Bur. of Standards Sci. Papers, vol. 17, no. 433, Apr. 10, 1922, pp. 611–626, 22 figs. Data are given on 28 specimens of iron and steel. Review of previous work on expansion.

STEEL CASTINGS

Specifications. The Trend of Specifications for Steel Castings, E. R. Young. Blast Furnace & Steel Plant, vol. 10, no. 9, Sept. 1922, pp. 463–466. General discussion covering important features such as chemical composition, physical properties, ductility and testing.

Tensile Properties. Tensile Properties of Steel Castings, Lawford, H. Fry. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 23 pp., 8 figs. Study of grades currently used for railroad service.

STEEL, HEAT TREATMENT OF

Annealing. Annealing, Tempering and Reheating (Recuit, Trempe et Revenu), Sigma. Métallurgie, vol. 54, nos. 27 and 28, July 6 and 13, 1922, pp. 992–994 and 1029–1030. Discusses operations in detail and their effect on steel.

STEEL, HIGH-SPEED

Heat Treatment. Shrinkage and Expansion of High-Speed Steel Due to Heat-Treatment, Marcus A. Grossmann. Chem. & Met. Eng., vol. 27, no. 11, Sept. 13, 1922, pp. 541–544, 2 figs. Describes tests undertaken to obtain data on amount which should be allowed for shrinkage or expansion. Results throw sidelight on nature of reactions taking place during heat treating.

STEEL MANUFACTURE

Bessemer Converter Plants. Modern Developments in Small Bessemer Converter Plants in Germany, Hubert Hermann. Eng. Progress, vol. 3, no. 8, Aug. 1922, pp. 173–176, 8 figs. Action of small converters; working arrangement; construction types; metallurgical process.

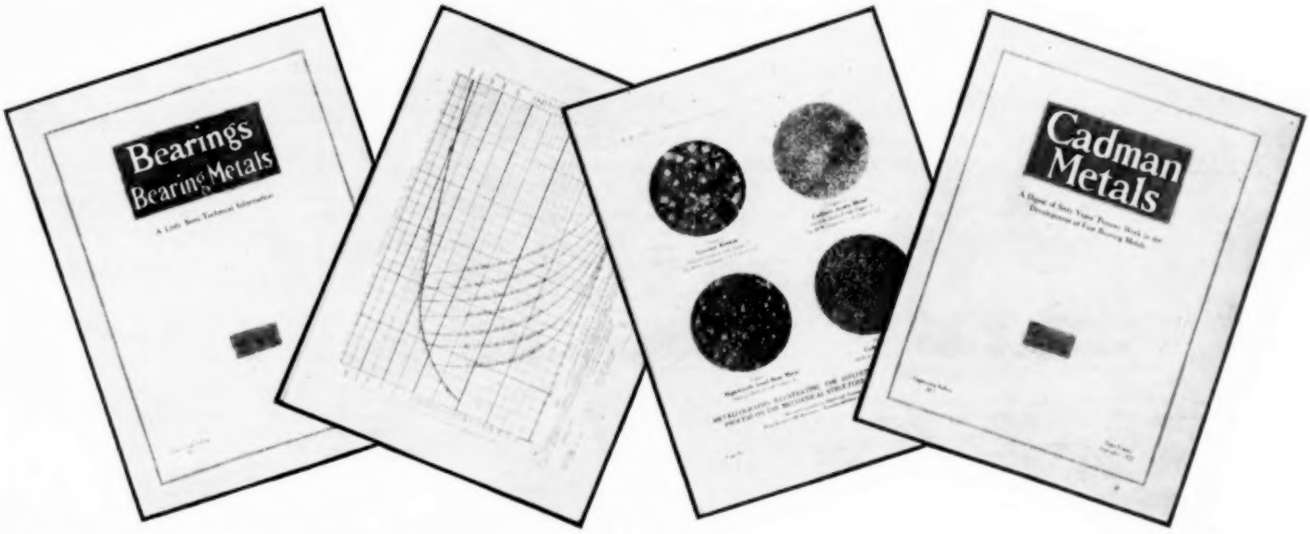
Bessemer Process. Use of Bessemer Process for Small Charges and Recent Experiences in a German Duplex Plant (Die Anwendung der Kleinbessemerei, namentlich in Duplexanordnung, und neuere Betriebserfahrungen in einer deutschen Duplexanlage), Hubert Hermanns, Giesserei-Zeitung, vol. 19, nos. 28 and 29, July 18 and 25, 1922, pp. 407–412 and 419–423 and (discussion), pp. 423–426, 16 figs. History of Development.

Direct Process. The Production of Iron and Steel Direct from the Ore, Ralph Whitfield. Iron & Coal Trades Rev., vol. 105, no. 2838, July 21, 1922, p. 84, 2 figs. Notes on the Basset and Bourcoud processes.

Without Pig Iron. Making Steel Without Using Pig Iron, Edwin F. Cone. Iron Age, vol. 110, no. 10, Sept. 7, 1922, pp. 585–586. "Scrap and Carbon" basic open-hearth process as employed at an Eastern plate mill; residual manganese an essential feature.

STEEL WORKS

British. The Devonshire Works of the Staveley Coal and Iron Company, Limited. Iron & Coal Trades Rev., vol. 105, no. 2843, Aug. 25, 1922, pp. 249–253, 15 figs. on pp. 263–270. Description



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of blast-furnace plant, coke-oven and by-product plant, and chemical works.

The Park Gate Ironworks. Engineer, vol. 134, no. 3479, Sept. 1, 1922, pp. 216–217, 6 figs. partly on p. 220 and supp. plate. Describes large plant near Rotherham, England. Details of blast-furnace, open-hearth and rolling-mill plants, and power house.

Electrification. A Review of Steel Mill Electrification, B. G. Lamme and W. Sykes. Assn. Iron & Steel Elec. Engrs., vol. 4, no. 9, Sept. 1922, pp. 545–566. Review of development.

German. German Development of the Iron Industry in Lorraine and Luxemburg Up to 1918 (Stand des deutschen Ausbaues der lothringischen und luxemburgischen Eisenindustrie bis zum Jahre 1918), Hubert Hoff. Stahl u. Eisen, vol. 42, nos. 27 and 28, July 6 and 13, 1922, pp. 1041–1050 and 1089–1097, 24 figs. Describes steel works and rolling mills of United Iron Works Burbach-Eich-Dübelingen at Esch.

Heat Balances. Heat Balances of Blast Furnace and Steel Plants, W. Trinks. Blast Furnace & Steel Plant, vol. 10, no. 9, Sept. 1922, pp. 451–456, 4 figs. Gives charts showing heat balance for uneconomical, average, economical, and ideally operated steel plants.

STOKERS

Bituminous-Coal-Burning. Burning Bituminous Coal on Stokers. Mech. Eng., vol. 44, no. 6, June 1922, pp. 373–374 and 381. Three papers, by G. E. Wood, O. J. Richmond, and R. A. Sanders, on stoker operation with soft coal, presented before Joint Fuel Conference of New Haven branch of A.S.M.E. New Haven Chamber of Commerce, and other engineering societies.

Costs and Efficiency. The Stoker from an Operating Viewpoint, Robert E. Dillon. Combustion, vol. 7, no. 3, Sept. 1922, pp. 155–157. Consideration of reliability, maintenance, efficiency, cost of operation, and first cost. (Abstract.) Paper presented at Stoker Mfrs. Assn.

Forced-Draft. The Burning of Ash- and Water-Rich Fuels on Forced-Draft Stokers (Die Verheizung stark asche- und wasserhaltiger Brennstoffe auf Unterwind-Vorschubrosten), H. Pradel. Wärme, vol. 45, no. 26, June 30, 1922, pp. 319–322. Results of series of evaporation tests and practical experiences with Pluto stokers show to what extent the ash and water content of fuel effects economy of its use on such stokers.

Pit-Refuse Utilization. Utilization of Pit Refuse for Raising Steam. Iron & Coal Trades Rev., vol. 105, no. 2839, July 28, 1922, pp. 120–121, 1 fig. Description of Bennis stokers for utilization of pit refuse in use at Gordon House Colliery, Durham, England. Results of tests.

Shovel. Shovel Stokers and Forced-Draft Horizontal Grates (Wurfbeschicker und Unterwindplanrost), H. Pradel. Wärme- u. Kälte-Technik, vol. 24, no. 15, Aug. 1, 1922, pp. 173–175, 6 figs. Describes new arrangement introduced by Adler & Hentzen, Coswig, Germany, for high-capacity boilers.

Underfeed, for Low-Grade Fuel. Burning a Low Grade of Fuel on Underfeed Stokers. Power, vol. 56, no. 7, Aug. 15, 1922, pp. 247–251, 8 figs. Description of plant in Minneapolis installed under 5,600-sq. ft. boilers. Tuyeres used to prevent clinker formation and steam jets to mix furnace gases.

STREET RAILWAYS

Cars, Double-End Turnstile. Double-End Turnstile Car Tried in New York. Elec. Ry. Jl., vol. 60, no. 8, Aug. 19, 1922, pp. 259–261, 5 figs. Third Ave. railway has remodeled one of its semi-convertible pay-as-you-enter cars and installed turnstiles and other automatic equipment to permit of one-man operation.

Two-Car Train. Two-Car Train Weighs 490 Lb. per Seat. Elec. Ry. Jl., vol. 60, no. 10, Sept. 2, 1922, pp. 317–319, 10 figs. Experimental two-car unit, built by Twin City Rapid Transit Co., weighs 51,500 lb. and seats 105 passengers; has low-floor, inside-journal bearings, trucks equipped with band brakes and front car heated with resistors.

T

TAPERS

Standard. Standard Tapers, Luther D. Burlingame. Am. Mach., vol. 57, no. 4, July 27, 1922, pp. 130–133, 3 figs. Statement of case for existing standards; suitability of tapers for specific jobs; objections to Jarno taper.

TERMINALS, MARINE

River. River Terminals and Water Depths, H. McL. Harding. Port & Terminal, vol. 2, no. 6, July 1922, pp. 9–10 and 24–25, 3 figs. Points out that proper design of inland river barges is important to effective development.

TERMINALS, RAILWAY

Design. Factors Governing the Design of Passenger Terminals, A. S. Baldwin. Ry. Age, vol. 73, no. 10, Sept. 2, 1922, pp 429–435, 1 fig. Analysis of operating conditions which influence plans for large station. Abstracted from report before Int. Ry. Congress in Rome.

TESTS AND TESTING

Brinell Ball Indentation. Some Measurements of the Shape of Brinell Ball Indentation, Fred E. Foss and R. C. Brumfield. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 24 pp., 13 figs. Description of methods used in investigation, analysis of results obtained and conclusions arrived at.

Methods and Machines. Report of Committee E-1 on Methods of Testing. Am. Soc. for Testing Matls. advance paper meeting June 26–30, 1922, 27 pp., 5 figs. Suggested definitions relating to methods of testing and for verification of testing machines.

TEXTILE INDUSTRY

Weaving Machinery. Weaving Machinery, L. B. Jenckes. Mech. Eng., vol. 44, no. 6, June 1922, pp. 375–381, 11 figs. Weaving styles and kinds of fabrics produced. Details of methods employed. Functions of special machine devices. Different types of looms. (Abstract.)

TEXTILE MILLS

Power Supply. Problems and Economics of the Textile Power Plant, Leo Loeb. Engrs. & Eng., vol. 39, no. 7, July 1922, pp. 260–265 and (discussion) 266–272, 14 figs. Methods of approach and analysis of problem of whether return on investment in betterments of mill power system will be comparable to return in dollars and cents on same amount of capital invested in extending manufacturing facilities. Applicability of purchased power from local public utility system.

THERMIT WELDING

Rails. Development of Thermit Welding (Entwicklungsgeschichte der Thermit-Schienenschweissung und ihre Lehren). Autogene Metallbearbeitung, vol. 15, nos. 12, 13 and 14, June 15, July 1 and 15, 1922, pp. 161–166, 184–188 and 195–197, 12 figs. Method of welding rails end to end by surrounding joints with liquid thermit mass supplying necessary heat. Apparatus, clamps, ratchets, etc., used.

THERMOMETERS

Specifications. Report of Committee D-15 on Thermometers. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 12 pp. Summary of existing specifications, and proposed tentative specifications for A.S.T.M. partial-immersion thermometers.

Transmitting. The "N and Z" Transmitting Thermometer. Gas Jl., vol. 159, no. 3087, July 12, 1922, p. 94, 4 figs. Description of thermometer patented by Negretti and Zambra having capillary tube made of high-expansion material.

TIRES, RUBBER

Drum-Built. Drum Built Tires. India Rubber World, vol. 66, no. 6, Sept. 1, 1922, pp. 799–800, 6 figs. New tire-building process.

Power Losses in. Power Losses in Automobile Tires, W. L. Holt and P. L. Wormeley. U. S. Bur. of Standards Technologic Papers, vol. 16, no. 213, May 20, 1922, pp. 451–461, 8 figs. Relates to power loss or energy dissipated as heat in automobile tires when operated under different conditions of axle load, inflation pressure, speed, and tractive effort.

V

VALVES

Cams and, Behavior of. Cams and Poppet Valves, S. E. Scholes. Gas & Oil Power, vol. 17, no. 203, Aug. 3, 1922, p. 181, 2 figs. Notes on autographic apparatus designed by author for demonstrating valve operation. From paper read before Instn. Automobile Engrs.

VENTILATION

Factory. Modern Factory Ventilation. Eng. Production, vol. 5, no. 100, Aug. 31, 1922, pp. 199–204, 15 figs. Describes plant developed by Ozonair, Ltd., Lond., principal feature of which is impregnation with ozone of all air circulated; also some typical installations.

The Elements of Ventilation in Industrial Works Frank E. Gooding. Indus. Engr., vol. 80, No. 8, Aug. 1922, pp. 369–377 and 410, 25 figs. Conditions that should be studied when processes are added or changes made.

Katathermometer. Recent Progress of English Investigators in Determining the Relation of Atmospheric Conditions to Fatigue. Heat. & Vent. Mag., vol. 19, no. 8, Aug. 1922, pp. 31–35, 3 figs. What the katathermometer has done in furnishing data for relief of workers in oppressive atmospheres.

VISCOSIMETERS

Redwood. The Redwood Viscometer, Winslow H. Herschel. U. S. Bur. of Standards Technologic Papers, no. 210, Apr. 10, 1922, pp. 227–246, 8 figs. Investigation of two common errors in viscosimetry with following conclusions: that error due to inaccuracy in Meissner formula for average head is negligible in ordinary work; that error due to cooling of oil after leaving outlet tube may be neglected at low temperatures but should be corrected at temperatures near boiling point of water.

W

WAGES

Systems. Wages, Harrington Emerson. Chem. & Met. Eng., vol. 27, no. 9, Aug. 30, 1922, pp. 400–403. Essentials of good wage system; how wages should be measured; how these theories work out in practice illustrated by results obtained in Ford industries.

WASTE HEAT

Utilization. The Utilization of Waste Heat. Mech. Eng., vol. 44, no. 8, Aug. 1922, pp. 513–518, 4 figs. Three papers presented before Lehigh Valley Section of A.S.M.E.: Waste-Heat Boilers, H. B. Smith; Utilization of Waste Heat in the Steel Industry, A. T. Lewis; Utilization of Waste Heat from Rotary Cement Kilns, Joseph Brobston. (Abridgment.)

Utilization of Exhaust Gas (Abgasverwertung), P. Morgenstern. Wärme, vol. 45, no. 28, July 21, 1922, pp. 343–347, 2 figs. Notes on heat transmission and influence of temperature on losses; utilization of waste heat; waste-heat plants in gas works; water-preheating arrangements of different types; saving effected by feedwater heating.

WATER POWER

Paper Industry. Relation of Water Power to the Pulp and Paper Industry in Canada, J. B. Challies and I. J. Johnston. Am. Soc. Civ. Engrs. Proc., vol. 48, no. 6, Aug. 1922, pp. 1403–1407, 1 fig. Importance of industry in Canada; total power installation; electric drive; motive power by Provinces; future power requirements.

WELDING

Cutting and. Welding and Cutting, F. Horner. Eng. Production, vol. 4, nos. 85, 86, 87, 88, 89, 90 and 91, May 18, 25, June 1, 8, 15, 22 and 29, 1922, pp. 469–473, 487–489, 517–520, 535–538, 565–568, 581–586 and 607–610, and vol. 5. nos. 92, 93, 94, 95, 96 and 97, July 6, 13, 20, 27, Aug. 3 and 10, 1922, pp. 13–17, 37–41, 55–58, 76–82, 112–118 and 133–137, 168 figs. Review of modern methods and appliances.

Electric and Autogenous. Electric and Autogenous Welding with Regard to Covered Weld Wires (Elektrische und Schmelzflammen-Schweissung unter Berücksichtigung von Schweissdrähten mit Umhüllung), C. Diegel. Stahl u. Eisen, vol. 42, no. 34, Aug. 24, 1922, pp. 1309–1315, 13 figs. Comparative welding tests showed autogenous welded seams to be stronger then electric. A covering suitable for electrically welded wire was not suitable for autogenous welding.

Forge Welding, Steel for. Steel for Forge Welding, Frank N. Speller. Mech. Eng., vol. 44, no. 7, July 1922, pp. 443–444. Discusses principal factors affecting welding quality of steel, and compares average results of 80 tests made on forge welds of hammer-welded pipe with original material. (Abridgment.)

Pressure Vessels. Some Principles of the Construction of Unfired Pressure Vessels, S. W. Miller. Mech. Eng., vol. 44, no. 6, June 1922, pp. 360–368, 15 figs. Discusses forge and fusion welding and riveting and factors affecting welding efficiency. Includes two appendices, first, dealing with testing of ten specimens of welded plates; second, dealing with testing of four half-inch plate-steel and two Armco iron welded tanks. (Abridgment.)

Problems. Welding Session Develops Salient Facts. Mech. Eng., vol. 44, no. 8, Aug. 1922, pp. 521–523. Gathering under auspices of Am. Welding Soc. and A.S.M.E. Boiler Code Committee emphasizes problems to be met in advancing art of welding.

Tube, Contraction in. Contraction in Tube Welding, Marcel Piette. Welding Engr., vol. 7, no. 8, Aug. 1922, pp. 19–20, 6 figs. Points out that distortion can be avoided by expanding pieces in opposite sense before welding. Translated from Revue de la Soudure Autogène.

[See also ELECTRIC WELDING; ELECTRIC WELDING, ARC; ELECTRIC WELDING, RESISTANCE; OXY-ACETYLENE WELDING; THERMIT WELDING.]

WELDS

Testing. Electrical and Magnetic Weld Testing as Applied to Butt-Welded Steel Plates, T. Spooner and I. F. Kinnard. Am. Soc. for Testing Matls. advance paper for meeting June 26–30, 1922, 11 pp., 7 figs. Describes series of laboratory tests applied to arc butt-welded steel plates to determine possibility of developing electrical and magnetic tests capable of revealing quality of such welds. See also Iron Age, vol. 110, no. 3, July 20, 1922, pp. 139–141, 6 figs.

WIND MOTORS

Induction Generators, Use of. The Use of Asynchronous Generators in Wind Motors (Ueber die Verwendung von Asynchrongeneratoren in Windkraftanlagen), Kurt Herzog. Elektrotechnische Zeit., vol. 43, no. 29, July 29, 1922, pp. 961–963, 6 figs. Points out advantages and disadvantages of three-phase-current generation by means of wind motors in mountainous regions; adaptability of asynchronous generators for such purposes.

WIND TUNNELS

Balances for. The Six-Component Wind Balance, A. F. Zahm. Nat. Advisory Committee for Aeronautics, Report No. 146, 1922, 12 pp., 8 figs. Description of three-dimensional aerodynamic balance capable of rapid and accurate measurement which was installed in 8- by -8-foot tunnel; translation mechanism; measurement of lift, drag, and side drag; rotation mechanism; etc.

WOOD

Fire-Retarding Chemicals for. The Effect of Chemicals on the Ignition Temperature of Wood, W. O. Banfield and W. S. Peck. Can. Chem. & Metallurgy, vol. 6, no. 8, Aug. 1922, pp. 172–176, 3 figs. Results of experiments carried out at Univ. of Brit. Columbia. Search for practical fire-retarding chemical.